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Plant of U. S. Metals Refining Company

IMPORTANT APPLICATION OF DIRECT CURRENT IN THE LEAD REFINING INDUSTRY

ELECTRICAL CURRENT, ASSISTED by chemical energy, is the predominating factor in the electrolytic process employed by the United States Metals Refining Co., at its Grasselli, Ind., plant, where approximately 100 tons of lead are refined every 24 hr. As received, this lead is about 98.5 per cent pure, and in the refining process, silver, gold, bismuth, antimony and copper are extracted in amounts which range in value in the order named.

FIG. 1. ENGINE ROOM VIEW SHOWING 220-VOLT UNIT

Lead as received is placed on the anode, or positive connection, the pure lead, by the influence of the flow of the direct current in a bath of hydrofluoric silicic acid, is deposited on the cathode plate, which is the negative terminal of the circuit. The various other metals which remain on the anode in sludge form are washed off and run through a filter press and, after the acid is washed out, are placed in an oil-fired reverberatory furnace and a process is followed by which the metals are separated.

WHAT THE LOAD IS

CURRENT CONSUMED in the electrolytic lead refining process amounts to approximately 15,000 kw.-hr. per day or 80 per cent of the load. This part, 5500 amperes, is delivered at 85 volts, while the balance of the output is furnished for lights and motors at a potential of 220 volts.

Peaks are unknown; the refining process is continuous, and a steady 24-hr. current demand follows in sequence. Any slight fluctuation in the lighting or motor

load has but little influence on the uniformity of the total load.

A load possessing these characteristics makes a worthy prospective customer for the central station, and although an extremely low rate was recently offered by a neighboring public utility plant, it was still in excess of the present power cost, and no guarantee could be given for an absolutely continuous service. This last condition is the all-important factor in an industry of this nature, in which the loss of electrical energy would completely paralyze the refining process and result in a shut-down of the works. During the 11 yr. in which the plant has been in operation, steam has been off the header but once.

Coal and Ash

Harrisburg, Illinois, screenings, with a heat value averaging from 11,500 to 12,000 B.t.u., are delivered to the siding just outside of the boiler room, are dumped and then carried up to a 30-ton hopper by a Stephenson-Adams bucket conveyor. To obtain the weight of the coal as fired, it is dropped into a traveling weigh hopper, which delivers to the stoker.

Ash and refuse are removed from hoppers below the ash pits with small cars running on tracks and are wheeled out and dumped along one of the 3 spurs extending outside the plant.

Boiler Room Equipment

Originally steam was furnished by 2 Stirling boilers, one rated at 400 hp. and the other at 250 hp. These are operated with forced draft, hand-fired, and carry a pressure of 160 lb. with 100 deg. superheat. Later a 516-hp. Edge Moor 4-pass water-tube boiler was installed and the Stirling boilers have since been kept as reserves. The Edge Moor boiler is equipped with a 6-plunger Riley underfeed stoker using forced draft, and supplies steam at 170 lb. pressure with 100 deg. superheat, control of draft being actuated by a balanced draft system. Tubes are kept clean with an Edge Moor intra-baffle soot blower.

Flue gases are now handled by a 150-ft. concrete stack 7 ft. in internal diameter. Percentage of CO_2 is recorded by a Sarco continuous CO_2 machine. Before entering the furnace, air is preheated by flowing along the baffled chambers which surround the flue to the stack, and with a stack temperature of 400 deg. a rise ranging from 20 to 40 deg. is obtained.

Driving the forced draft fans is a 20-hp. motor, which also operates the stoker, and the installation of a Reeves variable speed transmission makes it possible to vary the speed of the stoker without affecting the fan speed. This device, which is placed in the floor and interposed between the motor and stoker, consists of 2 pairs of spline-mounted disks fitted on 2 parallel shafts. The inner faces of the disk form a V-shaped groove into which is fitted a specially designed belt, having its bearing surface on the edges instead of the bottom. One set of disks acts as driver, the other set as follower, and the disks are actuated so that when the belt rides on a larger diameter on one pair of disks, at the same time it drives on a smaller diameter on the opposite pair of disks, thus increasing or diminishing the speed of the follower shaft. The disks are driven by means of double keys mounted in the shafts on which they slide when speed adjustment is being made. Hubs of the disks bear against specially constructed roller thrust bearings, thus reducing the friction to the least possible amount.

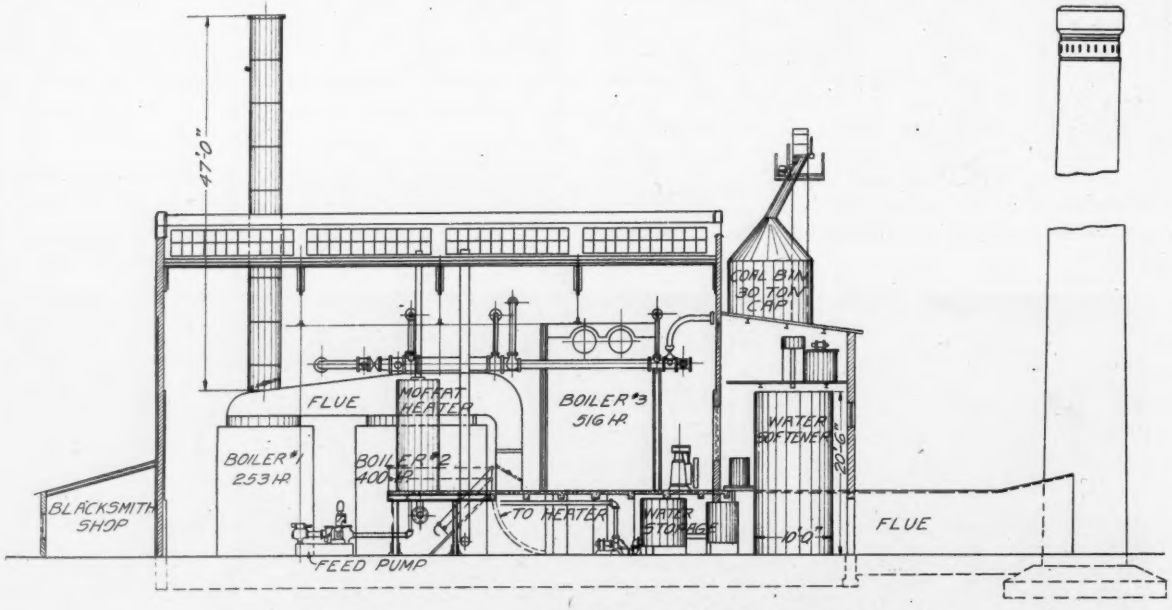


FIG. 2. DRAWING SHOWING ARRANGEMENT OF BOILER ROOM APPARATUS

Close steam pressure regulation is obtained with a Mason horizontal pressure controlling device operating a rheostat with step by step movement connected to the motor.

Located at one end of the boiler room is a gage-board equipped with a steam flow meter, steam pressure gage, stack temperature recorder, gages indicating draft under grate and over fire, and 2 electric tachometers. One

tachometer indicates the pounds of air per minute supplied to the furnace, the other, the pounds of coal fed per minute by the stoker. Their operating principle is extremely simple.

Attached to the fan shaft is a millivolt generator

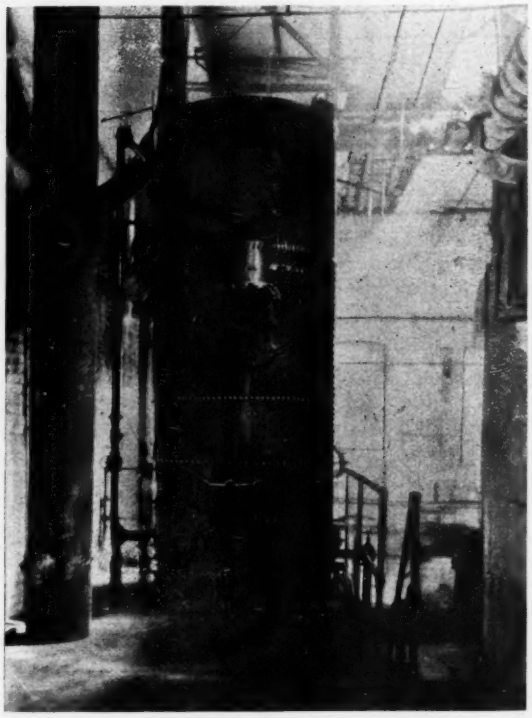


FIG. 3. MOFFAT FEED WATER HEATER

and with various speeds a corresponding reading is shown on the air tachometer. This instrument is virtually a millivoltmeter, but by the use of a factor based upon the volume of air supplied at various fan speeds, the reading is given direct in cubic feet of air per minute. The principle of the coal tachometer is similar; the millivolt generator is connected to the stoker shaft

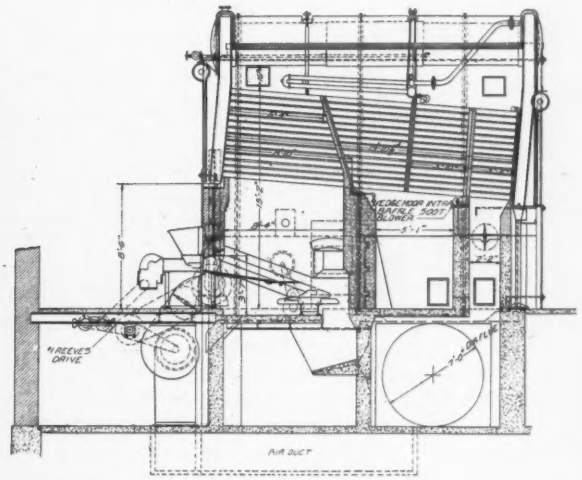


FIG. 4. SECTIONAL VIEW OF EDGE MOOR BOILER

and by employing a factor based upon the amount of coal fed by the stoker at varying speeds, a direct reading in pounds of coal per minute is indicated. Reference to these tachometers enables the engineer to tell at once whether or not the proper quantities of air are being supplied to give efficient combustion.

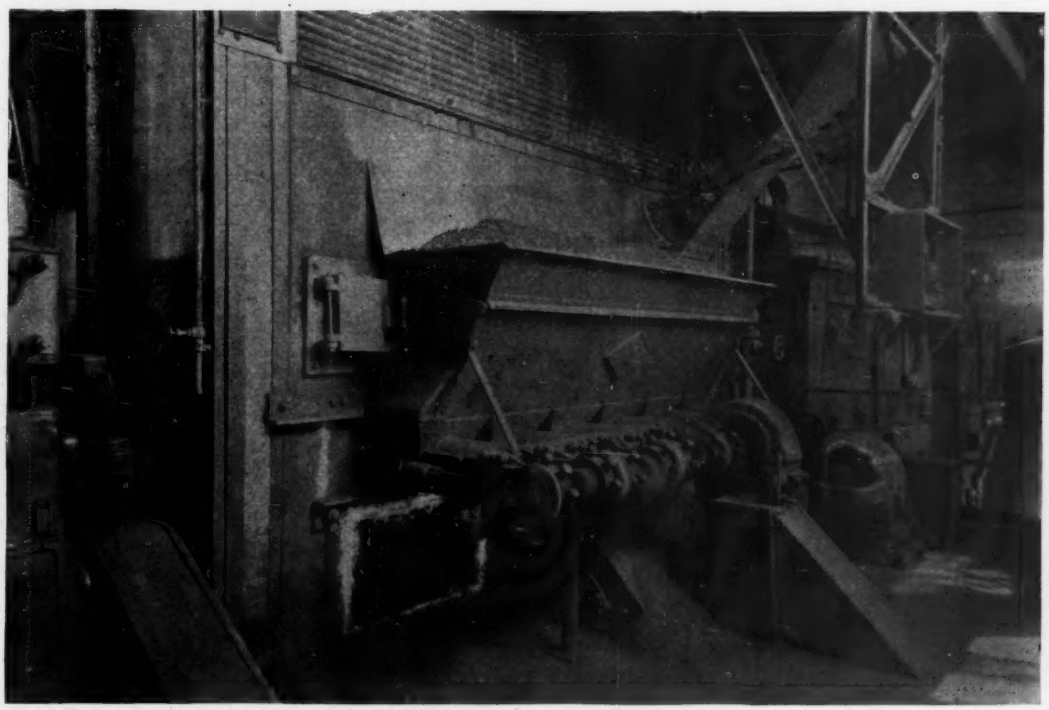


FIG. 5. RILEY AUTOMATIC STOKER

Feed and condensing water is taken from the Calumet River. Feed water, before entering the water softener, is heated to about 110 deg. by passing through a primary heater. Connected to the outlet of the treatment tank is an automatic water weigher which registers the weight of water before it is pumped to the open feedwater heater. Exhaust steam fed to the heater is usually supplemented by steam taken through a reducing valve

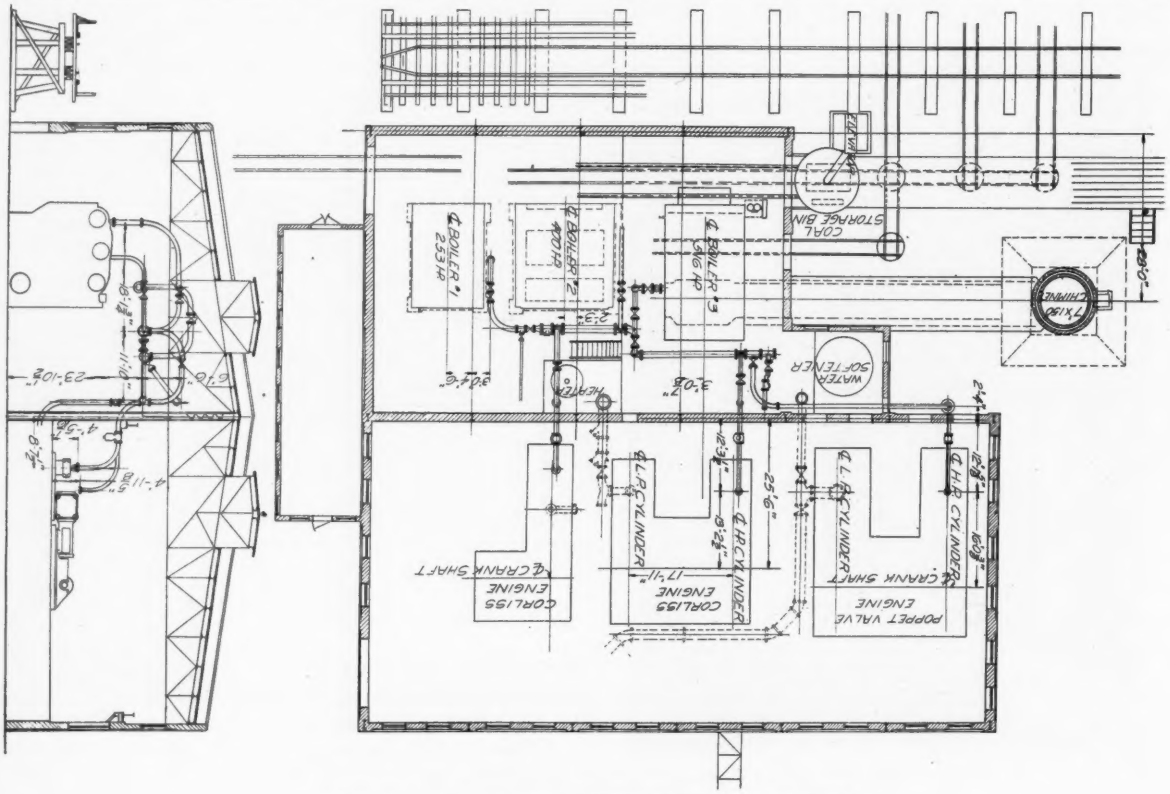


FIG. 6. PLAN DRAWING SHOWING GENERAL LAYOUT

PRINCIPAL POWER PLANT EQUIPMENT IN THE U. S. METALS REFINING CO. PLANT

No.	Equipment	Type	Size	Use	Operating Conditions	Maker
1	Boiler	Edge Moor	516 hp.	Steam Generator	Forced Draft. Stoker feed. 170 lb. steam.	Edge Moor Iron Co.
1	Boiler	Stirling	400 hp.	Steam Generator	Forced draft. Hand fired. 160 lb. steam.	Babcock & Wilcox Co.
1	Boiler	Stirling	250 hp.	Steam Generator	Forced draft. Hand fired. 160 lb. steam.	Babcock & Wilcox Co.
1	Stoker	Underfeed	6 plunger	Feed Large Boiler	Motor driven.	Sanford Riley Stoker Co.
1	Engine	Poppet-Corliss Cross-Compound	19 by 44 by 42	Drive Generator	170 lb. steam. 100 deg. superheat.	Nordberg Engine Co.
1	Engine	Corliss Cross-Compound	15 by 32 by 36	Drive Generator	170 lb. steam. 100 deg. superheat.	Nordberg Engine Co.
1	Engine	Corliss Tandem-Compound	13 by 26 by 36	Drive Generator	170 lb. steam. 100 deg. superheat.	Nordberg Engine Co.
1	Condenser	Barometric		Vacuum	26.75 in.	Worthington Pump & Machinery Corp.
1	Generator	D. C.	550 kw.	Electrolytic Current Auxiliary	100 volts, 5500 amp.	Crocker-Wheeler Co.
1	Generator	D. C.	270 kw.	Electrolytic Current Power and Light Current	85 volts, 5000 amp., 110 r.p.m.	Westinghouse Electric & Mfg. Co.
1	Generator	D. C.	200 kw.	Auxiliary—Power and Light Current	220 volts, 800 amp., 110 r.p.m.	Crocker-Wheeler Co.
1	Motor-Generator	D. C.	110 kw.		Motor, 110 volts. Generator, 220 volts.	Crocker-Wheeler Co.
2	Pumps	Compound Duplex	6 by 10 by 5 by 12	Boiler Feed	Steam driven.	Geo. F. Lake Co.
2	Pumps	Centrifugal		Condenser Circulating	Motor driven.	Worthington Pump & Machinery Corp.
2	Pumps	Centrifugal	4 in.	Service	Motor driven—1875 r.p.m.	De Laval Steam Specialty Co.
1	Pump	Duplex	10 by 16 by 10	Dry Vacuum	Steam driven.	Blake & Knowles Steam Pump Co.
1	Pump	Duplex	16 by 9 by 12	Fire	Steam driven.	C. H. Wheeler Mfg. Co.
1	Compressor	Horizontal	12 by 12	Compressing Air	Motor driven.	Laidlaw-Dunn-Gordon Co.
1	Compressor	Horizontal	7 by 10	Compressing Air		Laidlaw-Dunn-Gordon Co.
2	Motors	D. C.	12 hp.	Drive Circulating Pumps	Motor driven.	Crocker-Wheeler Co.
2	Motors	D. C.		Drive Service Pumps	220 volts.	General Electric Co.
1	Motor	D. C.	35 hp.	Drive Air Compressor	220 volts—1875 r.p.m.	Crocker-Wheeler Co.
1	Motor	D. C.	15 hp.	Drive Air Compressor	220 volts.	Crocker-Wheeler Co.
1	Motor	D. C.	20 hp.	Drive Stoker and Fan	220 volts.	General Electric Co.
1	Regulator	Balanced		Draft Control		The Engineer Co.
1	Feed Water Softener	Bartlett-Graver	3000 g.p.m.	Feed Water Treatment	Continuous hot.	Wm. Graver Tank Co.
1	Water Weigher	Automatic		Weigh Feed Water	Float controlled.	The Kennicott Co.
1	Feed Water Heater	Open	800 hp.	Heating and Purifying Feed Water	Exhaust steam.	Moffat Feed Water Heater Co.

from the receiver of the tandem-compound engine. Two compound duplex pumps, 6 by 10 by 5 by 12 in., are provided to feed the boilers.

In the Engine Room

Driving the main electrolytic current generator is a combined poppet-Corliss valve, cross-compound Nordberg engine, 19 by 44 by 42 in. A recent test of this engine showed an average steam consumption of 10.9 lb. of steam per i.hp. hr., operating with 170 lb. pressure, 100 deg. superheat, and 26.75 in. vacuum. Direct-connected to the 270 kw. electrolytic generator, which serves as an auxiliary unit, is a cross-compound Corliss engine, 15 by 32 by 36 in. Operating the 220-volt generator is a tandem-compound Corliss engine 13 by 26 by 36 in., shown in the foreground of view in Fig. 1, and auxiliary to this unit is a motor-generator set which delivers 220-volt current. Steam is supplied to the poppet-valve engine through a 7-in. branch; the other 2 engines receive steam through 5-in. branches.

Current is carried through conduits to a 5-panel switchboard, whence it is distributed to the various buildings. A Sangamo ampere-hour meter records the output, while voltage and amperes are indicated by Weston instruments.

Pumps and Compressors

Two motor-driven compressors, one 12 by 12 in., and the other 7 by 10 in., provide compressed air which is used by air hoists and in blowing back the metal in various processes. For dry vacuum service a 10 by 16 by 10-in. steam-driven duplex pump is connected to the condenser. Circulating water for the condenser is handled by 2 motor-driven 8-in. centrifugal pumps, and service water is supplied by 2 motor-driven 4-in. centrifugal pumps running at 1875 r.p.m. An underwriter's duplex fire pump, 16 by 9 by 12 in., having a capacity of 750 g.p.m., ensures ample fire protection.

Throughout the 11 yr. of continuous operation this power plant has been under the supervision of H. Reed, who is assisted by C. L. Anderson.

Safety

An old lady riding on a certain railroad for the first time asked the conductor, "How often do you kill a person on this road?" To which the conductor replied: "Only once, madam."

At its Grasselli plant the U. S. Metals Refining Co. aims to improve materially on this record. Many commendable provisions have been made, not only to prevent accidents which might prove fatal, but to safeguard the health of their men wherever possible. Adjoining a large comfort house which contains a wash room, locker room, and hospital, is a model restaurant where clean food is served at low cost. In order that clothing may be kept as fresh as possible, it is usually placed in wire baskets, which are suspended from the locker room ceiling. In addition to the usual facilities, shower baths are provided and the men are encouraged to keep as clean as possible. Supplementing the usual entertaining films shown at a movie show, given every 2 weeks by the company, is a safety-first film which outlines in an interesting manner the methods recommended to prevent accidents.

Patching Concrete Floors

ONE of the principal objections often raised against the use of concrete finished floors is the difficulty and cost of successfully repairing places that become worn or damaged. For best results, it is usually considered necessary to cut down the worn place at least 1½ in. into the unbroken concrete, under-cut the edges, clean out the dust and loose particles thoroughly, wash with a thin cement grout, fill in with a paste grout and finally float to a level surface a mortar of cement and crushed stone or gravel. The patch must then be kept moist for at least a week or 10 days, keeping all traffic off in the meantime.

W. P. Anderson, president of The Ferro Concrete Construction Co. states that his company often uses a method of patching concrete floors which is much cheaper and requires far less time than the method commonly used. Mr. Anderson's method requires the use of a mastic material made from a mixture of asbestos fiber and rubber gum. This mixture is applied with a trowel after thoroughly cleaning the damaged surface. Very little cutting of the old concrete is necessary, other than to break off loose particles. The gum can be worked to a feather edge so that it will readily join with the undamaged concrete surface and eliminate the undercutting required with the old style of patch.

A patch of this sort can be opened to foot traffic within a few hours and to heavy traffic within a day or so. It is thus possible to repair a much used portion of a mill or factory floor almost over-night. The cost varies with the size of the patch, but will amount to from 16 to 18 cents per square foot.

In Mechanical World, E. G. Beckwith gives a method for square roots of numbers below 2000 which is briefly as follows: Find the difference between the given number and the nearest even square. Divide this difference by twice the root of that nearest square and add the quotient to or subtract it from that root, according as the nearest square taken was less or greater than the original given number.

As an example: To find the square root of 27. 25 is the nearest square, the difference is 2, and the root 5. Divide the difference, 2, by twice the root ($2 \times 5 = 10$), and the quotient is 2/10 or 0.2. Add to 5, gives 5.2. The exact root is 5.196.

Again, required the square root of 119. The nearest square is 121, whose root is 11. The difference is 2, and dividing by 2×11, or 22, gives 2/22, or 0.091. As the square is greater than the number, subtract 0.091 from 11, giving 10.909. The exact root is 10.9087.

Required the square root of 387. The nearest square is 400; its root 20, and the difference 13. Twice 20 is 40, and this into 13 gives 0.33. Subtract from 20, leaves 19.67 as the root. The exact root is 19.672.

For a larger number, even, to find the square root of 1529. The nearest square is 1600, its root 40 and the difference 71. Twice 40 is 80, and this into 71 gives 0.89. Subtract from 40, leaves 39.11 as the root. The exact root is 39.102.

The method is thus seen to be sufficiently accurate for all practical purposes.

Engine Governors--I

FUNDAMENTAL PRINCIPLES FOR SPEED CONTROL; PENDULUM TYPE GOVERNORS. BY E. C. WELLS

OF THE different forms of engine governors, the shaft governor appears to be the most difficult to understand, especially when the elements of inertia and centrifugal force are considered.

If we first consider the meaning of the words "inertia" and "centrifugal force" we may more readily understand their effect in the engine governor.

CENTRIFUGAL FORCE

IF A BODY is fastened to a string and whirled, so as to give it a circular motion, there will be a pull on the string that will be greater or less, according as the velocity increases or decreases.

Suppose that the body is revolved horizontally, so that the action of gravity upon it will always be the same. According to the first law of motion, a body put

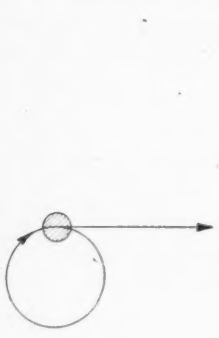


FIG. 1

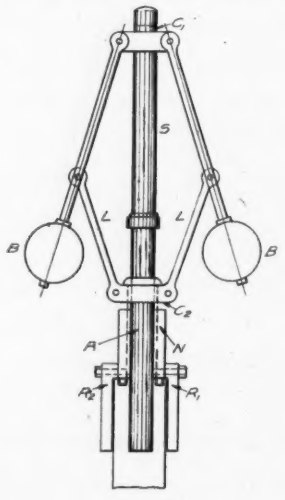


FIG 2

FIG. 1. ILLUSTRATING TENDENCY OF BODY TO MOVE IN TANGENT TO THE CIRCLE OF ITS MOTION
FIG. 2. SIMPLE PENDULUM GOVERNOR

in motion tends to move in a straight line unless acted upon by some other force, causing a change in the direction. When the body moves in a circle, the force that causes it to move in a circle instead of a straight line is exactly equal to the tension of the string. If the string were cut, the pulling force that drew it away from the straight line would be removed, and the body would then "fly off at a tangent"; that is, it would move in a straight line tangent to the circle in which it was traveling, as shown in Fig. 1. Since, according to the third law of motion, every action has an equal and opposite reaction, we call the force that acts as an equal and opposite force to the pull of the string the "centrifugal force," and it acts "away from the center of motion."

INERTIA

INERTIA is that quality of matter by virtue of which a body cannot put itself in motion nor bring itself to rest. To do either it must be acted upon by some external force. Inertia is not a force, although it is often so called. If a force acts upon a body and puts it in motion, the effect of the force is stored in the body, and a second body, in stopping the first, will receive a blow equal in every respect to the original force, assuming that there has been no resistance of any kind to the motion of the first body. If a body is at rest, it must be acted upon by a force in order to be put in motion, and, no matter how great the force may be, it cannot be "instantly" put in motion.

The resistance thus offered to being put in motion is commonly, but erroneously, called the resistance of inertia. It should be called the resistance due to inertia.

The automatic cutoff engine is regulated by a governor, which is one of 2 types, either the pendulum (flyball) governor, or the shaft governor. All engines which require a disengagement of some of their parts in order to effect the cutoff are usually fitted with flyball governors.

Most steam-engine governors depend for their action on the effect that the centrifugal force that is developed in a weight revolving around an axis outside of its center of gravity has in overcoming a varying resistance force. The weight is so suspended that the centrifugal force developed by its rotation is opposed by a variable resistance. When the speed and centrifugal force increase, the weight moves outwards and the resistance increases until it balances the increased centrifugal force; when the speed decreases, the centrifugal force becomes less than the resistance and the weight is forced toward the axis; as the weight moves toward the axis, the resistance decreases until it is again balanced by the centrifugal force in the new position. This motion of the weight is transmitted by a suitable mechanism to the valve that controls the flow of steam to the cylinder.

To illustrate more fully, let us consider for a moment the pendulum or flyball governor.

Figure 2 represents a simple pendulum governor, a form of governor much used on Corliss engines. For the purpose of making the governor symmetrical and preventing the bending action on the spindle that would result from the effect of a single weight, 2 balls are used, B, B. These balls are suspended from the collar, C_1 that is fastened to and rotates with the spindle, S. Links L, L connect the arms to which the balls are attached on the sleeve, N. This sleeve does not rotate but is free to slide up and down on the spindle. When the balls fly outwards, the sleeve is pulled upward by the links, L, L, and the collar, C_2. This motion is transmitted to the valve gear by the connecting rod, R_1. To prevent sudden fluctuations of the governor, a rod, R_2, operates a piston in a cylinder filled with oil.

DEFECTS OF THE SIMPLE PENDULUM GOVERNOR

IT IS EVIDENT that the weights of a centrifugal governor can change their position with respect to the axis only when there is a change in the speed of rotation; it is, consequently, evident that such a governor cannot keep the speed of an engine at an absolutely uniform

rate under all loads. Another defect in the simple pendulum governor is the fact that gravity—the force that acts in opposition to the centrifugal force developed by the rotation of the weights—is too small to overcome quickly the inertia of the weights when there is a sudden reduction in the centrifugal force. This makes the action of the governors slow in responding to a sudden increase in load; the result is that before the governor can move far enough to open the valve and admit the steam required for the greater load, the speed of the engine will drop considerably below that corresponding to the load. Any attempt to make the governor act more promptly by increasing the weights will be futile, since the mass whose inertia must be overcome is increased in the same proportion as the increase in weight.

The weighted-pendulum governor, shown in Fig. 3, is a modification of the simple pendulum governor that adds greatly to the range of motion of the centrifugal weights for a given range in speed. In this governor the centrifugal weights are small and their centrifugal force is made comparatively great by running them at a high speed.

In addition to their own weight, the balls must lift a large weight, or counterpoise, W. The effect of the counterpoise is to add to the resistance against which the centrifugal force developed by the rotation of the balls must act without changing the centrifugal force itself, as would be the case if extra weight were added to the balls. The result is that the balls must revolve at a higher speed in order to develop a centrifugal force great enough to overcome the added resistance. The change in the height of the governor for a given change in speed of rotation is also greatly increased. This is called increasing the sensitiveness of the governor.

Isochronous Governors

It is evident that if a governor is so made that the resistance to the outward motion increases at the same rate as the increase in the radius of the circle in which the weight rotates, there will be a speed at which there will be equilibrium between the centrifugal force and the resistance for any position of the weight. If there is no change in the resistance, with any increase in speed above that at which the resistance balances the centrifugal force, the latter force will carry the weights to their extreme outer position, while the weights will be held in their extreme inner position for any speed below that at which there is equilibrium between the forces. This condition of constant ratio between the centrifugal force, and the resistance opposed to it is called isochronism, and a governor proportioned in such a manner that this condition is fulfilled is called an isochronous governor.

Isochronism is desirable in that it implies a sensitive governor that will respond to the slightest changes in speed. A perfectly isochronous governor, however, will be too sensitive for any practical use. At the one speed at which there is equilibrium, the weights will stay in any position and will have no control over the steam supply. The slightest change from this speed will have the effect of shifting the weights to one or the other "extreme" position, and either shut off the steam supply entirely or open the valve wide.

Since, for a given speed, the balls of a simple pendulum governor can have but one position in which there is equilibrium between their centrifugal force and the effect of gravity, such a governor is not isochronous. By suspending the balls from crossed arms, however, as in Fig. 4, the height of the governor, i. e., the vertical distance between the centers of the balls and the point where the center lines of their arms intersect the axis of the spindle, remains nearly constant for any position

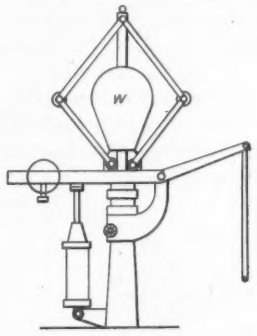


FIG. 3

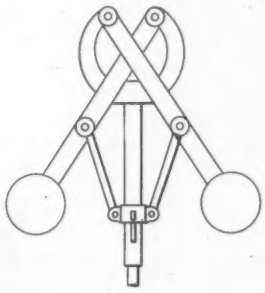


FIG. 4

FIG. 3. WEIGHTED PENDULUM GOVERNOR
FIG. 4. PENDULUM GOVERNOR WITH CROSSED ARMS

of the balls, and the condition of isochronism is very nearly fulfilled. A number of governors working on this principle have been built; but they have the defect common to all gravity governors of requiring heavy weights in order to be sufficiently powerful, and, in consequence, are subject to the disturbing effects of inertia.

Much interest is being manifested throughout the country in what has been designated National Touring Week. An effort is being made to induce every car owner who can do so to devote the week of Aug. 6 to 12 to touring, and the indications are that thousands of motorists will heed the call of the road at that time.

All indications point to a big success, as from every quarter of the country come reports of preparations on the part of car owners to devote the second week in August to touring, either locally or extensively. By taking part in this big demonstration, each motorist will help to impress highway commissions and public authorities generally with the importance and necessity of keeping up the good roads movement and carrying to a splendid completion what has been so well begun.

The output of bituminous coal in the United States during the first 6 mo. of 1916 was the greatest ever recorded in any half-year period. Estimates by C. E. Lesher, of the United States Geological Survey, based on returns from over 100 railroads originating coal and coke shipments, indicate that the production during this period was 261,000,000 tons, an increase of 35 per cent over the first 6 mo. of 1915, and of 5 per cent over the last 6 mo. of the same year, and greater by several million tons than the record established in the last half of 1913. Compared with the first half of 1915 the exports from the Atlantic seaboard during the last 6 mo. have increased about 10 per cent, and the exports to Canada have nearly doubled.

Oil Fuel--II

Oil Pumps

PUMPS designed, and usually preferred, for handling crude or fuel oils are of the duplex piston pattern, except for large capacities accompanied by heavy pressure, where an outside-packed plunger pump is to be recommended.

The handling of high-gravity fuel oils, running from 30 deg. Baumé up, and quite liquid in consistency, is usually best accomplished by the use of an ordinary duplex pump fitted with brass-ring packing in the pump pistons and brass valves and special oil-proof gaskets in the pump cylinder joints to overcome the solvent action of the oil. For heavy viscous oil, like Mexican

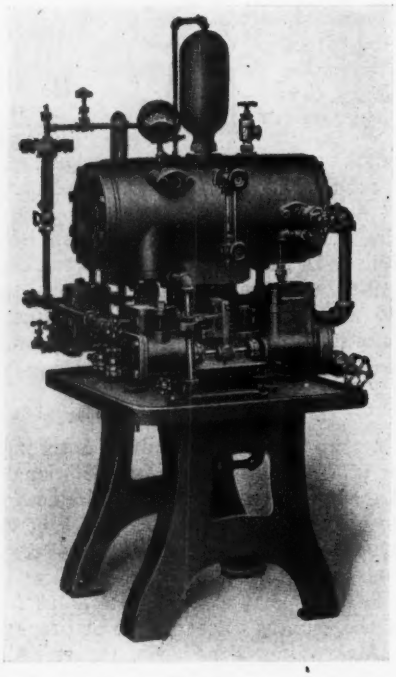


FIG. 2. FUEL OIL PUMPING OUTFIT

crude, the ordinary duplex piston pump is suitable, provided a size sufficiently large is selected to keep down the oil velocities through the ports and passages and valve seats in the pump cylinders to a minimum.

The type of pump ordinarily used for pumping fuel oil to burners, where the oil pressure will not exceed 150 lb. per sq. in., is a pump similar to the Snow Duplex piston-pattern pump. In selecting this type for low-gravity oils, it is advisable to use nothing smaller than a 4½ by 2¾ by 4-in. size, as the ports and valve passages in small pumps are too restricted to operate successfully with oils of this character, and it might be well to remember that the 4, 5 and 6-in. stroke duplex fuel-oil pumps have valve areas equivalent to 35 to 40 per cent of the piston area and should operate at speeds, say, not to exceed 30 to 40 single strokes per minute each piston, and 10 and 12-in. stroke pumps 25 to 30 single strokes.

These pumps are often set in duplicate on a cast-iron stand with oil heater, strainers, bypass valves, thermometers, gages, etc.

With this arrangement one pump is operative and the other is a reserve. A pressure governor or regulator is set for the oil pressure and controls the pump automatically. These systems are usually used in connection with low-pressure burners of the steam or air atomizing type. In rare instances, the single-cylinder pump is used, although in this country the duplex pump is favored.

For high-pressure fuel-oil systems it is necessary to use pumps designed for operating against oil pressures up to 200 lb. per sq. in. For horizontal work, the duplex-pattern pump of the valve-plate style makes a very efficient and satisfactory pump for the service. For Naval installations or for marine work where floor space is limited, the vertical duplex Admiralty pump attached to the bulkhead is usually employed. This type of pump is good for 300 lb. maximum oil pressure.

The duplex fuel-oil pump has been universally regarded as the standard in the United States, while in

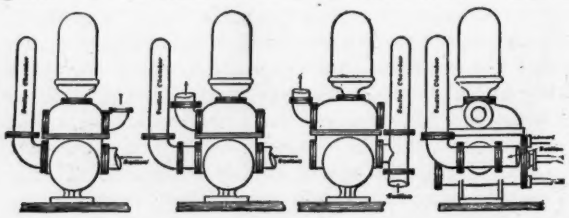


FIG. 3. APPLICATION OF SUCTION AIR CHAMBERS TO FUEL

England, for Admiralty purposes, they occasionally use vertical simplex pumps, which, if properly fitted up with suction air chamber and discharge air chamber, will give almost as steady and constant a flow of oil as the duplex pump.

The simplex pump, both of the horizontal and vertical type, has better suction qualities than the duplex. The former are usually made longer stroke and permit the use of half the number of valves, which necessarily have to be of larger diameter than in the duplex pumps, and consequently are more favorable for the flow of heavy, viscous oils. On board ship where the bottom of the fuel oil tanks is placed below the location of the pump, the simplex pump, with its better suction qualities, will drain the tank in a more satisfactory manner than a duplex pump. A suction air chamber should be so arranged as to permit the direction of flow through the suction pipe to cushion against the air or gas contained in the suction chamber, rather than have the flow pass directly into the suction opening of the pump.

While the reciprocating pump has been largely used for pumping oil to burners, there are several makes of rotating plunger pumps which give satisfactory results for this purpose, and have the advantage of giving a much steadier oil pressure. These pumps utilize the well-known principle of the rotary engine, and experimental tests have shown them well qualified for use with mechanical-atomizing oil-burning installations.

Piping

For U. S. Naval service the oil piping specified is seamless drawn steel, with flanges expanded on. The joints are scraped and made up metal to metal. Manila paper gaskets are allowed on suction piping. Screwed fittings are used on connections under ¾-in.

For merchant service extra-heavy welded-iron or steel pipe is used, with screwed joints and with extra-heavy galvanized-iron fittings. Flanges are screwed on the pipe and manila paper or card board is used for gaskets, or special oil-proof packing, of which there are several kinds in the market. Rubber is not allowable on account of the sulphur in the oil. Copper piping is not used on account of the sulphur, but brass and composition fittings, valves, unions, etc., may be used safely.

The suction piping should be large, the Newport News rule for designed velocity of Mexican oil through suction pipes being not over 20 ft. per min., the oil being heated to reduce the viscosity to about 300 deg. Engler. For discharge pipe lines they consider 100 ft. per min. allowable in small pipes, the viscosity being reduced to 15 deg. Engler or under.

For valves on suction lines designed for viscous oils, the gate valve is preferable, on account of reduced friction. On delivery lines, globe valves of a regrinding type give satisfaction. There is no occasion to use needle

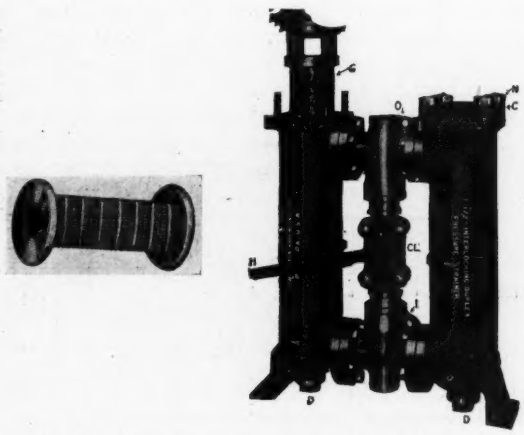


FIG. 4. STRAINER USED WITH PEABODY BURNER
FIG. 5. SCHUTTE & KOERTING OIL STRAINER

valves. Where fine regulation is required, as in some cases with steam atomizers, there are several types of valves which open gradually on slotted or "V" shaped passages which give better and more consistent results than the needle type. All valves for high-pressure work should be extra heavy with bonnets screwed over, not into, the valve body. Specially designed and packed plug cocks may be used in small sizes for quick action.

Strainers

The comparatively small orifice of the mechanical sprayer necessitates special care being taken in straining the oil. Most makes of burners are fitted with individual strainers, that used in the Peabody burner being shown in Fig. 4. The spool is wrapped with 3 turns of brass netting of 40-to-the-inch mesh, fastened with No. 20 gage brass wire. This is easily renewable when necessary.

Strainers of the McComb type are also used both on the pump suction and delivery lines. See Fig. 5. These are fitted in duplicate, so that alternate cleaning is possible without allowing the oil ever to pass unfiltered. There is little variation in design of filters, but considerable difference in practice as to size of mesh, which varies from ¼ in. to 1/16 in. on the suction strainers and from 1/16 in. to 100 mesh to the inch in the discharge strainers, the latter being rather too fine and fragile for good practice. There is some question as to whether strainers are needed on both suction and delivery oil lines. This will depend greatly on the oil—but the viscous oils hold tenaciously every foreign substance that gets into them, and straining facilities should rather be increased than diminished. At all events, the oil delivered to mechanical spray burners must be as clean as practicable to prevent clogging, and to minimize wear of the orifices.

Uniform Boiler Laws

THOMAS E. DURBAN, Chairman of the Administrative Council of the American Uniform Boiler Law Society, reports progress as follows:

In New York, after a bill was unanimously passed by the House and Senate, it was vetoed by the governor on the ground that a law of this kind would make the present provisions of the boiler law permanent, and requirements could only be changed by legislative enactment. By having the code adopted by the Industrial Commission, amendments and changes can be incorporated by the act of the commission without new legislation, and the Industrial Board has full authority to adopt the code. The Industrial Board has signified its intention of taking committee action as soon as this procedure can be reached, and there is little question that the code will be adopted soon.

In Louisiana a bill has been introduced, but during the latter part of the legislative session, which involves great difficulty in getting immediate action. A bill will be presented at the next session of the Michigan legislature by John C. McCabe, inspector for the city of Detroit. Many manufacturers of boilers and prominent users are assisting in securing the passage of such a bill.

The matter is under consideration and making progress in Alabama and Illinois, with the probability that the Inspection Department of the city of Chicago will independently adopt the code in the near future.

In Texas the code is favored by the Cotton Ginners' Association, by the Texas Cotton Seed Crushers' Association and by Governor Ferguson. The most probable source of difficulty in Texas is the attaching of this bill for the adoption of the code to other bills for boiler inspection and license laws.

In St. Louis, the code is before the Council, and there is little doubt of its final passage. It is being considered in connection with correction of errors of some former ordinances which have been adopted by the Council.

The committee will be glad to receive suggestions and advice as to the pushing of the adoption of the code by the various state legislatures and city councils, such suggestions to be sent to Mr. Durban, Erie, Pa.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Transformer Efficiency and Regulation

DISCUSSION OF NATURE AND CAUSE OF LOSSES AND THEIR BEARING UPON EFFICIENCY; EFFECT OF LOAD AND POWER FACTOR VARIATIONS. BY W. M. MCCONAHEY

TRANSFORMER losses considered in figuring efficiency are 2 in number, viz., iron loss and copper loss. There is a small dielectric hysteresis loss in the insulation which is practically impossible of separate determination. This is kept small by the use of ample distances between points at different potential, and the resultant heating is kept small by liberal supply of oil ducts through the insulation. It is negligible except in a few rare cases of high-voltage transformers, and the little there is, is included in the iron-loss measurement.

IRON LOSS

THE IRON LOSS consists of 2 parts, viz., hysteresis loss and eddy-current loss. These 2 losses can be separated, but there is no reason for doing this in commercial testing, so that the two are included in all iron loss measurements. The iron loss depends upon the frequency and the voltage applied to the windings and is not affected by the load on the transformer except by the small amount that it is reduced, due to the voltage drop through the primary windings. This drop is so small as to be practically negligible to the extent that the iron loss is considered constant for all loads, provided the applied voltage is kept constant. A decrease in the frequency or an increase in the voltage increases the iron loss, and vice versa.

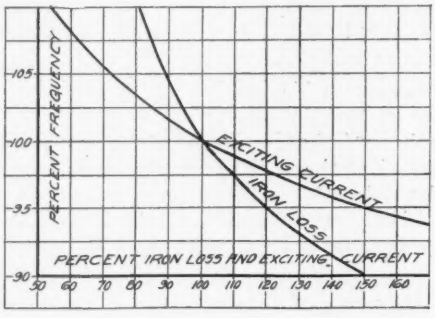


FIG 1. EFFECT OF CHANGE OF FREQUENCY ON EXCITING CURRENT AND IRON LOSS

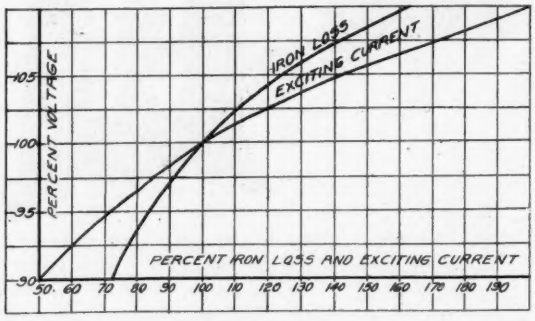


FIG. 2. EFFECT OF CHANGE OF VOLTAGE ON EXCITING CURRENT AND IRON LOSS

The frequencies used chiefly in this country are 25 and 60 cycles. While a transformer can be operated at a higher frequency than that for which it was designed (with poorer regulation on inductive load), it cannot be operated at a much lower frequency without also reducing the voltage, which of course means reducing the rated output. For example, a transformer designed for operation at 60 cycles will generally not operate satisfactorily at normal voltage at 50 cycles. The reason for this is that the iron loss, and particularly the magnetizing current, will be increased beyond reasonable limits, as shown in Fig. 1.

It is customary to design transformers so that they can, when necessary, be operated at a voltage 10 per cent in excess of normal. With this increase in voltage, the iron loss will be increased approximately 60 per cent and the magnetizing current approximately 100 per cent, as shown in Fig. 2. The amount by which the voltage can be raised above normal is limited chiefly by the amount of magnetizing current that is considered reasonable. Ordinarily the magnetizing current of power transformers varies between the wide limits of 4 or 5 per cent of full-load current for some of the largest sizes to 15 or 20 per cent for small high-voltage transformers. For the average size of transformer, the magnetizing current will vary between the limits of 6 and 10 per cent. An increase of more than 10 per cent in voltage may raise the magnetizing current to such a high value as to increase the heating of the transformer and appreciably reduce the power-factor of the system.

The sheet steel used in transformers contains a comparatively high percentage of silicon and is, therefore, popularly known as "high silicon" steel. The loss is very low compared with other kinds of steel, but the

permeability is also comparatively low, and this tends to increase the magnetizing current. However, the reduction in loss more than counterbalances the decrease in permeability.

Copper Loss

The copper loss varies as the square of the current flowing in the windings. In addition to the useful current that passes to the electrical circuits outside the transformer, there are certain other currents that circulate only in the transformer windings and are not only useless, but are actually harmful, since they increase with increase in load on the transformer and produce extra heating. They are of 2 kinds,—eddy currents and circulating currents.

Eddy currents are set up in the individual conductors by the leakage field produced among the windings by the currents flowing in them. They are always present, but can be limited to a small value by careful design. They increase with the width and cross-section of the conductor and are kept within reasonable limits chiefly by winding several comparatively narrow separately insulated conductors in parallel to form one complete conductor. Eddy currents exist to the greatest extent in transformers having heavy, low-voltage, high-reactance windings, that is, transformers for operation with rotary converters.

Circulating currents flow in the loops formed by 2 or more conductors connected in parallel. They are caused by the leakage field inducing unequal voltages in the different parallel conductors. Like eddy currents, they are most liable to cause trouble in heavy, low-voltage, high-reactance windings. They can be eliminated largely by the proper transposition of the conductors when connecting up the coils.

The calculated I^2R losses are those losses in the windings caused by the useful currents flowing through them to the electrical circuits to which they are connected. The losses measured by a wattmeter are the I^2R losses plus the losses due to eddy and circulating currents, and are therefore always greater than the calculated I^2R losses. The difference will vary from a very small amount in some cases to as much as 50 per cent or more in extreme cases. As a rule, the wattmeter losses do not exceed the I^2R losses by more than approximately 20 per cent, except that in high-reactance transformers such as mentioned above, this figure may be doubled.

If the resistance of transformer windings at some given initial temperature is known, the resistance at some higher temperature may, according to the A. I. E. E. rules, be found as follows: Divide the sum of 234.5 plus the higher temperature in degrees Centigrade, by the sum of 234.5 plus the initial temperature, also in degrees centigrade, and multiply the quotient thus obtained by the value of the resistance at the initial temperature. Assuming that efficiency guarantees in one case are made on the basis of a temperature of 25 deg. C., and in the other on the basis of 75 deg. C., we have the initial temperature equal to 25 deg. C., and the final temperature equal to 75 deg. C. Then, from the above, the resistance of the windings at the higher temperature may be found by dividing, 234.5 plus 75, by 234.5 plus 25, and multiplying the quotient thus obtained by the value of the resistance at the initial temperature. As a result, we have the resistance at the final temperature equal to 1.19 times the resistance at the initial temperature; that is, the resistance at 75 deg. C. is 19 per cent greater than at 25 deg. C., and, therefore, the I^2R loss is also 19 per cent greater.

Hence, it is apparent that efficiency guarantees based on wattmeter measurements of copper losses are not as high as those based on calculated I^2R losses. It is also apparent that since I^2R losses increase with increase of temperature, the lower the temperature basis is assumed the higher the efficiency guarantee can be made. For these reasons a fair comparison cannot be made between 2 different efficiency guarantees unless they are both based on the same temperature and method of measurement. According to the Institute rules, transformer efficiency and regulation guarantees should be based on wattmeter measurements of copper loss, corrected to a temperature of 167 deg. F. (75 deg. C.).

Efficiency

The efficiency of a transformer may be defined as the ratio of the power output at the secondary terminals to the power input at the primary terminals. Since the losses in the transformer make up the difference between

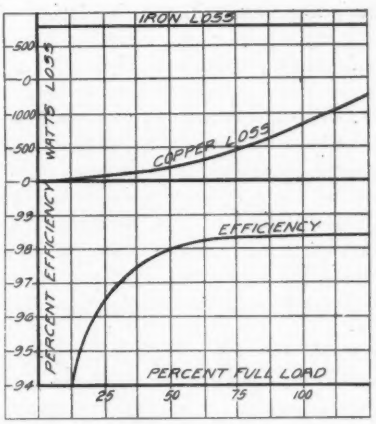


FIG. 3. TYPICAL TRANSFORMER EFFICIENCY CURVES

the power input and the power output, the efficiency may be stated as the output divided by, the output plus losses; or, input minus losses, divided by input.

If the iron loss at normal voltage and the copper loss for any given load (generally full load) are known, the efficiencies can easily be calculated, bearing in mind that the iron loss is a constant quantity and that the copper loss varies as the square of the load.

The efficiency is maximum when the copper loss and the iron loss are equal. Thus, if the copper loss and the iron loss are equal at full load, the efficiency is maximum at full load. If the full-load copper loss is less than the iron loss, the maximum efficiency occurs at some load greater than full load. If the full-load copper loss is greater than the iron loss, the maximum efficiency occurs at some load less than full load. As a rule, the full-load copper loss as compared with the iron loss is greater for 25-cycle transformers than for 60 cycles.

The above figures are based on the transformer delivering its output at 100 per cent power-factor, which is the basis on which all standard performance guarantees are made and is in line with A.I.E.E. rulings. If, however, the guarantees are based on the transformer delivering its output at some power-factor less than 100 per cent, then the efficiencies will be less.

Regulation

In general terms the regulation is the variation in secondary voltage with variation of load and power-factor. The greater the load and the lower the power-factor, the greater is the drop in voltage as the load is increased. The voltage drop varies directly as the load, provided the power-factor remains constant. A leading power-factor tends to raise the voltage, and a lagging power-factor to lower it. On non-inductive load (a load of 100 per cent power-factor) the regulation, as a rule, exceeds the copper drop by only a small amount. However, with transformers having high reactance this is not the case, since the reactive component of voltage adds considerably to the copper drop. On inductive load the regulation depends chiefly upon the reactive drop; hence, the less the reactive drop, the better the regulation, and vice versa. Particularly good regulation on inductive load is not of much importance except for distributing transformers.

Low reactance may influence the design adversely in the way of cost and efficiency, and when dealing with the large transformers, particularly those of low frequency, may make the short-circuit stresses so high that it will be difficult, or possibly out of the question, to brace against them successfully. On the other hand, with a carefully worked out design, there is no good reason for a high reactance. High reactance generally tends towards a cheaper design, but the resulting poor regulation will in most cases more than offset the possible small saving in cost. As a rule, the tendency is for the reactance to increase with increase in size, voltage and frequency.

Transformers for the operation of compound-wound rotary converters, particularly those for railway work, are as a rule designed for an internal reactance of approximately 15 per cent. This is done for the reason that the high reactance tends to cause the direct-current voltage to rise as the load increases.—The Electric Journal.

Current Transformer Precaution

Theory of Action Wherein Lies Danger of Excessive Voltage and Overheating. By Gordon Fox

THE secondary circuit of a current or series transformer should not be opened or left open while current is flowing through the primary circuit. There are 2 reasons for this: first, a dangerous voltage is induced in the secondary circuit; second, the current transformer is likely to overheat. The action may be explained as follows:

The voltage across the terminals of a current transformer is not constant, as in a potential transformer. The primary voltage is the impedance drop across the transformer due to the primary current, which varies according to the external load and is not influenced by the current transformer. The transformer impedance drop depends upon the number of primary turns and the flux density in the magnetic circuit and if in a given transformer, the number of turns is fixed, the drop depends upon the flux density. When the secondary circuit is closed, its current opposes the magnetizing action of the primary current and thus restricts the flux. The secondary current is much smaller than the primary current, but there are more turns in the secondary winding. The ampere turns in primary and secondary windings are thus nearly equal and, as they are opposing each other in magnetizing influence, they restrict the flux density in the iron to a low value. The secondary voltage depends upon the flux density. With closed secondary circuit, the flux density is low and the current flowing through the short-circuited winding moderate. Increase of primary current causes increased flux density and consequent increased secondary current. If the impedance of the secondary circuit be increased, the secondary current tends to drop, but this lowers the opposing action of the secondary, allows the flux to increase, raising the secondary voltage and thus maintaining the current at its original value. If the secondary circuit be opened, there will be no opposing action to the magnetizing influence of the primary current. The flux density is therefore high and the iron may easily overheat. With high flux density, the induced secondary voltage is large, often reaching 200 to 300 v. effective value. Due to the saturation of the iron, this voltage will have a high peak value, perhaps exceeding 500 v., and is therefore dangerous. There is no danger in handling the secondary circuits of a current transformer as long as these circuits are kept closed, but if they are opened, they become immediately subject to high potentials, as shown.

In the Morning News of Dallas, Tex., under date of June 30, an excellent editorial appears on the subject of Uniform Boiler Construction Laws. This advocates strongly the adoption of the American Society of Mechanical Engineers' code, showing the benefit to the public in securing safe construction, the benefit to users in the lower cost and insurance rates available, and the benefit to manufacturers in the uniformity of requirements for boilers to be used in different parts of the country.

It shows, also, the value of the A. S. M. E. code in the consideration that has been given to all points by the best engineers in the country, and advocates strongly the adoption of this code by the various states. It calls attention, also, to the fact that in many cases the engineers who helped to formulate this code, really deprived themselves of income by so doing, since many of them were engaged in consulting work and in drawing up of specifications of boilers, which, if the code is universally adopted, would be unnecessary. It calls attention, also, to the use of these rules as a textbook by many of the best engineering schools in the country, and the approval of the code by practically all of the leading technical societies and the larger boiler manufacturers.

Don't put rosin and such sticky stuff on a belt to make it pull, but use something that will increase the pliability of the belt and it will cling to the pulley better. —The Gas Engine.

Foreign Development in Power Plant Field

THE SCHULZ DRAFT AND TEMPERATURE REGULATOR. BY J. H. BLAKEY

SOMETIME ago M. Frank, of the Paris-Lyons Railroad, France, made a number of experiments to determine what relation of diameter to length in a boiler fire-tube will give the greatest evaporation. The tubes tested were all of the same diameter—46 mm. or about 1¾ in. The result of these experiments is shown in the accompanying chart, Fig. 1, which shows very definitely that a tube of this diameter has the highest evaporative value at a length of from 4.5 to 5 meters, or about 14 to 17 ft.

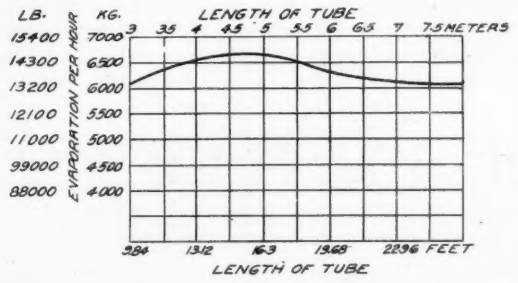


FIG. 1. RELATION BETWEEN EVAPORATION AND LENGTH OF FIRE TUBE

There is no record of experiments with tubes of other diameters, but it seems probable that this relation of diameter to length of tube will be true, approximately at least, for other sizes.

Consequently it may be considered, until more evidence is at hand, that if the relation of diameter to length varies much from 1 to 100, the highest evaporation is not to be expected. As this relation is not always attainable, inventors have attempted to produce devices for increasing the transmission of heat through the tube walls. Many of these have the defect of interfering too much with the draft, or are difficult to put in place and remove, thus causing a considerable expenditure of time when the tubes are to be cleaned, or they cause the clogging of the tubes with ash.

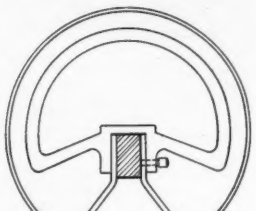


FIG. 2

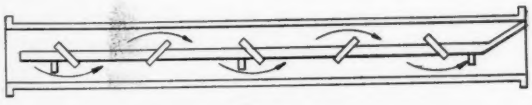


FIG. 3

FIG. 2. END VIEW OF TUBE FITTED WITH DEFLECTORS
FIG. 3. VIEW SHOWING LOCATION OF DEFLECTORS

The problem to be solved may be stated as follows: The hot gases passing through a straight and comparatively smooth tube give up their heat to the walls of the tube only at those parts of the gas stream which are in contact with the walls, that is at the circumference of the cylindrical stream, leaving the inner part or "core" to pass into the chimney almost as hot as it entered the tube. Of course, an interchange of heat by conduction and convection does take place, as is shown by the chart, up to the length required by the 1 to 100 relation; but if the tube is shorter than this, the core of the gas stream evidently retains a great part of its heat. Consequently, the stream must be broken up so that the heat of its inner part may be brought into contact with the tube walls.

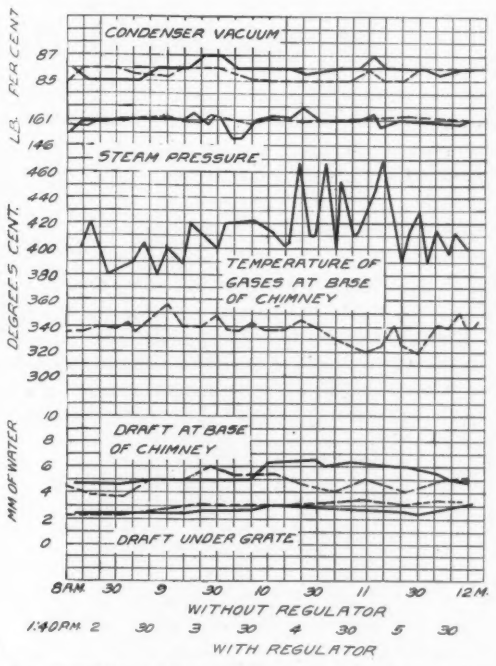


FIG. 4. RESULTS OF TEST WITH AND WITHOUT REGULATOR —WITH REGULATOR SHOWN DOTTED

A device which does this and which is free from the defects enumerated above, has been brought out in Germany under the name of the Schulz Draft and Temperature Regulator. This consists of a series of deflectors of suitable size and shape, mounted on a steel bar and placed in a certain number of the fire tubes. It will be seen by the end view, Fig. 2, that the position of the deflectors leaves the lower half of the tube free. The result of this is that the draft is increased in this part because of the obstruction above, and the ash which accumulates here is therefore carried off more completely into the base of the chimney than when the tube is unobstructed.

The number of deflectors to each tube, the angle at which they are set, and the proportion of the whole number of tubes which are to be equipped with the regulator,

must be determined by experiment, although certain rules will at once occur to the practical man. For instance, a boiler with chimney and setting giving an excess of draft, or one using forced draft, will give good results with the regulator under conditions which would not be considered with a boiler having draft which is barely sufficient. Also, if the tubes are longer than 100 times their diameter, it is doubtful whether the presence of the deflectors will increase the evaporative power at all; in fact, it seems probable that they will be effective in proportion to the amount by which the tube falls short of this length.

The accompanying chart, Fig. 4, and the table below, give the results of 2 4-hr. tests with a marine boiler with 2 furnaces and 112 tubes, 76 of which were, in the second test, fitted with the regulator. It will be noticed that this resulted in practically the same production of power with a consumption of 220 lb. less coal—a saving of over 10 per cent.

RESULTS OF TESTS OF MARINE BOILER WITH AND WITHOUT THE SCHULZ TEMPERATURE AND DRAFT REGULATOR

	Without	With
Duration of test, hr	4	4
Composition of Fuel, per cent Water	4.2	4.4
Ash	4.7	3.6
Combustible	91.1	92.0
Total fuel, lb.	1980	1760
Fuel per sq. ft. grate surface, lb.	20	17
Fuel per sq. ft. heating surface, lb.	.68	.6
Horsepower developed	205	207
Feed water temperature, deg. F.	37.6	37.6
Steam pressure, average, lb.	160	161
Condenser vacuum, per cent.	85.9	80.5
Temp. of gases at base of chimney, deg. F.	766	639
Draft under fire, inches of water.	0.12	0.11
Draft at base of chimney, inches of water	0.23	0.25

Measuring Water with a Weir Meter*

V-NOTCH METER WITH RECORDING MECHANISM BASED ON BUOYANCY PRINCIPLE. BY E. G. BAILEY†

FOR measuring water at or near atmospheric pressure, a V-notch or rectangular weir offers many advantages. The flow curve is such that greater accuracy is readily obtained over a wider range in rate of flow than with the Venturi or Pitot tubes. From an accurate knowledge of the flow curve for any given shape of weir notch, it is possible to use the level of the water above the notch to record continuously the rate of flow and integrate it so that the total may be read from time to time. The nature of the flow curve of a V-notch weir as shown in Fig. 1 brings out clearly the point that

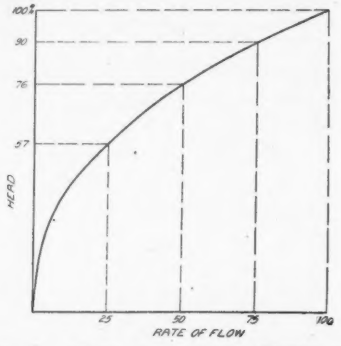


FIG. 1. FLOW CURVE OF V-NOTCH WEIR

at low rates of flow there is proportionately a great deal of head, or power, to operate any float-driven mechanism. The converse is true at the higher heads, where a very slight change in head means a much greater change in rate of flow.

Accuracy of the V-notch has never been questioned, but the points of primary importance are to measure accurately the head and to be sure that this measurement is referred back to the true zero of the notch. These points are difficult enough when using hook gages with micrometer screws in a hydraulic engineering laboratory, and even more so when continuous recording and integrating mechanism is used to measure the rate and total flow.

Zero level can be readily obtained in test or calibration work if a permanent hook gage point is riveted to the weir plate as shown in Fig. 4. This can be accurately located in the machine shop and is absolutely correct by construction.

It is always preferable to have chart records on uniformly graduated charts and in order to use the best form of integrating devices, it is essential to have a

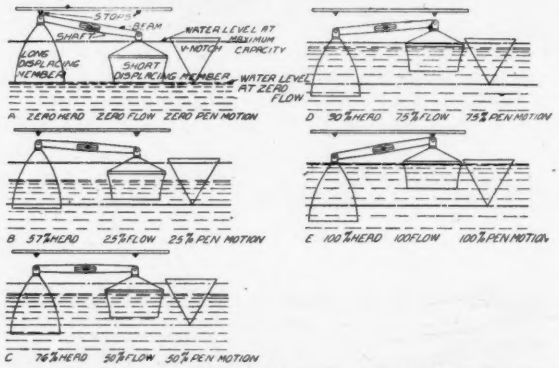

STOP
BEAM
SHAFT
WATER LEVEL AT MAXIMUM CAPACITY
V-NOTCH
LONG DISPLACING MEMBER
SHORT DISPLACING MEMBER
WATER LEVEL AT ZERO FLOW
A ZERO HEAD ZERO FLOW ZERO PEN MOTION
D 90% HEAD 75% FLOW 75% PEN MOTION
B 57% HEAD 25% FLOW 25% PEN MOTION
E 100% HEAD 100 FLOW 100% PEN MOTION
C 76% HEAD 50% FLOW 50% PEN MOTION

FIG. 2. METER MECHANISM BASED ON BUOYANCY PRINCIPLE

motion directly proportional to the rate of flow instead of proportional to the head.

The mechanism shown in Fig. 2 operates on the buoyancy principle. The displacing members are exactly balanced and weighted so that they are heavier than water and do not act as floats. If they were of equal and uniform cross-sectional area, the rising of the water level would produce no motion but would merely cause them to become lighter on their knife edge supports by an amount equal to the weight of water displaced; but,

*Read before the Ohio Society of Mechanical, Electrical and Steam Engineers.

†President, Bailey Meter Co.

by properly shaping these spun copper displacing members, a powerful motion that is directly proportional to the actual flow is obtained directly from the main shaft itself.

In Fig. 2, diagram A shows the positions of the 2 displacing members at zero flow, with their bottoms on the surface of the water at a level with the lowest point of a V-notch. Diagram B shows the positions of the displacing members when the rate of flow is 25 per cent of the maximum capacity of the meter. It is noted that the level of the water has increased to 57 per cent of the total range in head. The motion of the displacing members, and also the recorder pen, has not been relatively as much as the change in head; but it is directly proportional to the rate of flow. The total motion of each displacing member is, of course, less than the total change in water level. The maximum head is about 10 in., and the corresponding motion of the displacing members is 4 in.

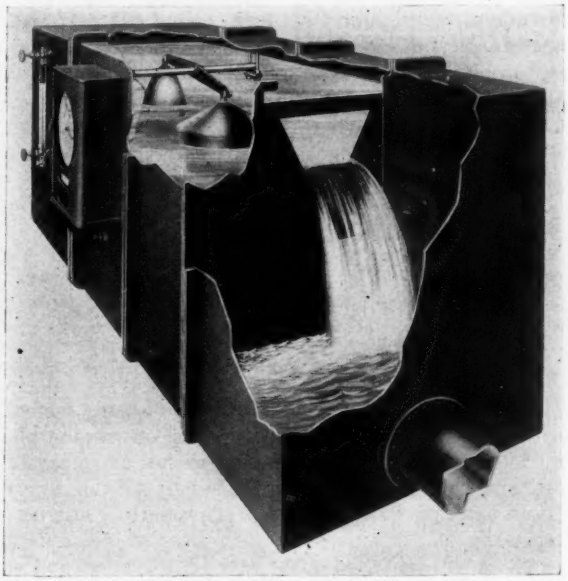


FIG. 3. VIEW OF METER SHOWING WORKING MECHANISM

Diagrams C, D and E show the positions of the displacing members when the V-notch is discharging 50, 75 and 100 per cent of its maximum capacity respectively. The last 25 per cent in the rate of flow is effected by only a 10 per cent increase in the head. In all cases, the volume of the 2 displacing members below the surface of the water is equal.

The working arrangement of these displacing members is shown in Figs. 3 and 4. The beam which carries the displacing members on monel metal knife edges is fastened to a shaft supported on monel metal knife edges. The end of this shaft extends through a pressure tight bearing and carries the recorder pen and integrator driving directly on its outer end.

Principal among the many problems that have been more or less troublesome on other types of meters as well as of the weir type, are imperfect drive due to vibration and the wearing smooth of the driving disk.

The integrator which has been found satisfactory is shown in Fig. 5. In this the disk is driven by the same clock movement which drives a chart, the disk making 2 revolutions an hour. The counter is suspended from a knife edge bearing on the clock frame and is moved across the disk by an arm extending from the main shaft which also carries the recorder pen. The follower wheel, which is in contact with the clock-driven disk, bears in the center for zero flow and is moved outward to a radius of 3½ in. at maximum rate of flow.

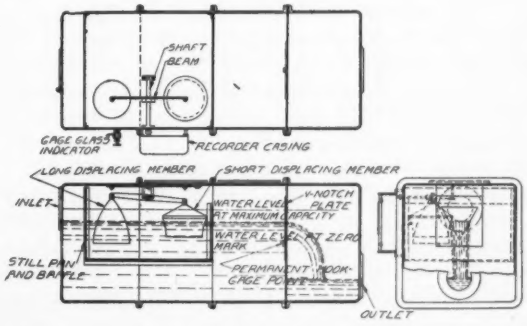


FIG. 4. DIAGRAM OF METER WORKING MECHANISM

This follower wheel is provided with a large number of rollers on its circumference which practically eliminate friction as it is moved across the disk and also prevent wearing the disk smooth, so that continued accuracy is obtained over an indefinite period of time without attention. The axis of the follower wheel is mounted slightly inclined from the perpendicular to the clock-driven disk so that the follower wheel bears against its

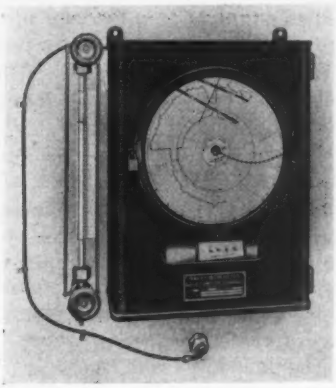


FIG. 5. INDICATING, RECORDING AND INTEGRATING PART OF BAILEY WEIR METER

projecting edge instead of its extreme circumference. This gives a greater arc of contact and eliminates error due to slip. This wheel is held against the disk by a flat spring and a small pressure of this part prevents any error due to vibration. This arrangement also simplifies the construction so that spur gears are used to drive the countertrain.

AN AMERICAN consular officer in the United Kingdom writes that a firm in his district is desirous of obtaining a centrifugal type oil-extracting machine. The machine is employed in extracting oil from waste used in power houses, etc. Blue prints of the machine desired may be inspected at the Bureau of Commerce or its district offices.

Practical Points on Raw Water Ice---I

ADVANTAGES OF RAW WATER ICE PLANT; ENGINE ROOM MACHINERY; METHODS OF DRIVE; OPERATING HINTS. BY A. G. SOLOMON

MAKING ice from raw or undistilled water is rapidly taking the lead in the ice industry. Great success has been attained both for clearness and purity. There is no oil or objectionable gases to be eliminated and the ice made from pure raw water is a better commercial article than the distilled water variety. Of course, there are solid matters in all water which must be filtered out. Some particles in raw water are held in solution at certain temperatures, while at other times they are precipitated. Chemical analysis should be resorted to so as to determine just what solids the water contains and what is the best way of getting rid of them.

This article is written by an operating refrigerating engineer and will not deal with the chemical end of the plant, but only with the practical part as it happens every day.

Raw water plants are all about the same in construction and differ but little in the agitation of the water in the cans. One of the greatest advantages of a plant of this kind is that it can be built in almost any resident portion of a city, as there is no smoke, coal dust or ashes as would be the case in a distilled water plant where boilers are required.

Some people have an idea that at least evaporators must be used to supply water for core filling; but this has been proved beyond a doubt to be unnecessary, as the raw water will answer just as well. A heating plant is required, but that need make no more smoke or dirt than the heating plants of the other buildings in the neighborhood.

METHOD OF DRIVING

MOTOR-DRIVE is the general power in use; gas or oil engines are also used in places where electric power is not plentiful or is expensive. In those parts of the country where oil and gas are cheap, those engines are economic and give excellent results. Motor drive is the proper thing in the larger cities, where the power is sure to be constant and cheap.

In a great many of these plants, it will be found that the motors are too small for the heavy load sometimes put on the ammonia compressors; for instance, a plant having 120-ton ice making capacity in one unit and driven by a 300-hp. motor. That will figure out nicely and will work fine under some conditions, but there are times when the condensing water is warmer than usual, and the ice tank temperature a few degrees higher than what is wanted. In such a case, the load must be kept light on the ammonia compressor to keep the motor from burning out or the circuit breaker from knocking out.

The condenser pressure must be kept down and, to do that, the back pressure must be kept much lower than what would be required for the brine temperature. The compressor does not handle the amount of gas it should, as that depends on the density and the density or weight depends directly on the back pressure carried. The ice making capacity is in such cases cut down with a corresponding increased horsepower per ton. A steam engine can be loaded till it slows down, but it is a rather ticklish job to judge exactly when a motor has all the load it will stand.

In the following table is shown the different rating of horsepower and compressor capacity, but it must be taken into consideration that nearly all, if not all such tables are based on a condensing water temperature of not higher than 70 deg. F., and often as low as 60 deg. F. Such temperature is available at some times and in some places, but not always, and the motor should be large enough to stand the full load when the water is warm and the pressures are high. Find out the hardest operating conditions in the locality where the plant is to be built and then see that all the parts of the plant are built in proportion. A 100-ton compressor is not much good during a hot season if the motor will only stand for an 80-ton load, as is often the case.

Horsepower of Motor	Ref'g Cap.	Ice Making Cap. Tons
10	5	2½
20	15	9
50	40	25
75	60	37
100	80	60
200	170	105

If this table is based on 70-deg. condensing water, it will be rather difficult to get capacity out of the plant during the time when the water reaches a temperature of 80 or even 90, as it does in some parts of the country.

If the raw water ice plant is properly constructed, especially as pertains to relative sizes of the different parts, it will be found to be easy of operation and economic both in labor and maintenance.

THE ENGINE ROOM

THE ENGINE room will contain the ammonia compressors, condenser pumps, blowers and their motors, together with the switchboard and perhaps some auxiliary machinery as may be found necessary. The usual light machine, which is generally a source of trouble and worry, is done away with, as lights are gotten from the central plant, which supplies current for power. The ammonia compressor can be of any type and its construction is the same as any of the steam-driven kind. One little, but very important, difference will be noticed; that is the bypass line, which connects from the discharge to the suction side and is connected between the compressor and the suction and discharge valves.

STARTING UP

IN STARTING the machine, the suction valve is left closed and the discharge and bypass valves are open. The check valve in the discharge line will keep the condenser pressure from the cylinder. The motor is started and the machine brought slowly up to speed. Then the

bypass valve is closed and the suction valve opened slowly, so as to guard against a slug or liquid being drawn into the compressor.

These bypass valves often give trouble by leaking. The gas passing through this line while starting up causes excessive heat and often the metal disk will be melted out. An extra disk, ready for use, should be on hand so that it can be put in in case that it is found that the one in use has begun to leak. Usually the leakage can be plainly heard, but at times it will be detected by the bypass line staying hot.

Another point that requires attention is to see that the check valve in the discharge line does not leak and allow liquid to get into the line from the condenser during such time as the compressor is shut down. If it is known that the check valve is leaking, the main valve between the check and the condenser should be closed immediately after the machine is stopped and opened just before starting up again.

If liquid is known to be in the line, it is good policy to use pumpout connections when starting up and by so doing, clear the discharge line and put the liquid in the suction. Grind in the check valve with emery at the first opportunity.

In cases of trouble with liquid, it is almost impossible to get started, as the circuit breaker will be knocked out; but, by getting a few revolutions at a time, the compressor will gradually clear itself. While handling the motor in this way, the resistance coils will get pretty hot; but they will stand a great heat, so there is slight danger of doing any damage. Sometimes, on large units, where 2 ammonia compressors are pulled by the same motor, it is found necessary to take down the connecting rod on one side so as to be able to start and get rid of the liquid which is in the discharge lines. This does not often happen; but it might happen any day, especially in the winter, when the machine is shut down a great part of the time.

Sometimes the power will be cut off at the power house or the circuit breaker will come out while there is a full load on the compressor. The proper thing to do when this happens is to stop the ammonia from flooding the compressor.

The first valve to be closed is the liquid injection into the cylinder if such a valve is in use. Next, close the suction and then the main liquid valve or the expansion valves feeding the coils. Then pull out the switch and put in the circuit breaker, and when everything else is ready, start up again.

Some motor-driven compressors are equipped with electrically operated valves in the suction line, which close automatically whenever the current is shut off the motor.

In testing the condensers, ice tank coils and other parts of an ice plant of the motor-driven variety, extreme care must be taken. In a steam-driven plant, the compressor can be run very slowly while the air pressure is being pumped, thus avoiding excessive heat; but a motor is run at full speed and the discharge temperature of the air reaches a dangerous point. This high temperature might cause the oil used for lubrication to flash, and this has been the cause of the bursting of pipe and fittings. Especially is it dangerous to test out an old plant where old oil is lying in all parts of the system and some ammonia and permanent gases are also present; best to be on the safe side and run a few minutes at a time and then shut down long enough to allow the parts to cool, which may be a little slow and more troublesome, but is much more safe to life and property.

One more small matter that needs some thought in operating a constant speed compressor is the getting of the required back pressure when starting up after being shut down for a time. If the system is allowed to pump down low before the liquid is turned on, it will be found hard to build up again without flooding the evaporating coils. If, before shutting down, these coils have been pumped down low, it is a good idea to open the liquid a short time before starting the machine. This will give you something to work on for a start and it will be easier to regulate the expansion valves in the shortest time.

Do not allow a belt to slip or it will be ruined in a very short time if not burned in two at once. If close to the compressor when the belt begins to slip, the suction valve should be closed enough to take some of the load off till you have a chance to tighten up on the belt by means of the screws for that purpose.

Condenser pumps are generally of the motor-driven centrifugal type and will give little if any trouble. As their speed is constant, the flow of water is controlled by the opening or closing of the discharge valve. On this style of pump, the discharge valve can be entirely closed and no harm done to either pump or motor.

If (as should be) there are 2 centrifugal pumps cross connected, and it is desired to change from one to the other and still keep a continuous stream of water, the one to be started must be gotten up to speed with the discharge valve shut. After speed is attained the discharge is opened and the other pump shut down and its discharge shut. If the discharge is opened before starting, the pump will be reversed by the water from the other pump and a fuse will be blown out. The same procedure of handling also applies to the blowers, which supply air for the agitation of the water in the cans. In this case, however, it is best to stop the one and close its discharge valve first, then open the discharge on the dead one and start. Sometimes it will happen that a blower will run reversed and it will then draw the core water out and might damage the blower with the water thus drawn in.

Pressure carried on the blower must be determined to suit each individual plant, for it will vary according to temperature of brine (which governs length of freezing time) and kind of water used. The general pressure varies from 2½ to 6 lb. The slower the freezing and the less sediment in the water, the less pressure required. When a low temperature is maintained in the ice tank, the agitation must be rapid and higher pressure is required. This part of the raw water system must be studied and tried out, for no one can tell another just what pressure to carry or just how much air to put into a certain amount of water in a given length of time.

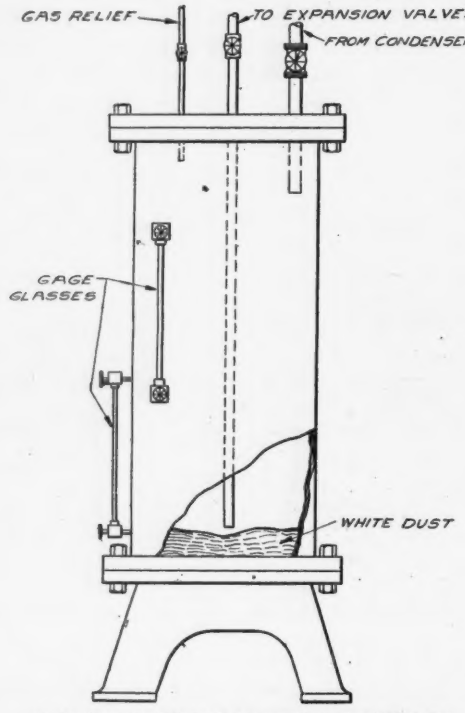
The openings through which the air passes into the ice cans are, as a rule, very small, being about 1/16 in. or less in diameter. These openings can be increased by drilling larger if more air is required; but, before drilling all of them, it is advisable to enlarge 1 or 2 and note the effect.

Galvanized Pipe Gives Trouble in Ice Plant

By C. E. Anderson

SOME time ago I read an article in Practical Engineer regarding galvanized pipe for ammonia condensers (pipe galvanized on the inside), in which the writer made an inquiry whether anyone has noted any bad effects on the system or the ammonia charge by using pipe work galvanized on the inside.

As a general rule, no pipe that is galvanized on the inside should be used in a refrigerating system, for the simple reason that sooner or later the galvanizing will peel off and pass with the ammonia into the different parts of the system. Reaching the expansion valves, it will invariably clog or stop them up, causing an unending amount of trouble. It may even travel as far as the ammonia compressor cylinders, where it will score and cut the valves and cylinder, which means shutting down to rebore cylinder and regrind the valves.



SHOWING LOCATION OF WHITE PRECIPITATE

The question has often been asked, "Will the galvanizing affect the ammonia itself; that is, will it cause disintegration of the ammonia charge?"

This is rather an open question; as yet, no extensive experiments, as far as I know, have been made to determine what effect galvanizing has on the ammonia charge.

I heard of an ice plant that was being overhauled, which had considerable trouble with disintegrating of the ammonia. An ammonia purifier of the evaporating type was installed in this plant. It was not unusual to draw from 3 to 4 qt. of dead liquid or water from the system each 24 hr. The system was gone over carefully several times by experts and no leaks could be found where any water or brine could enter into the system, so evidently leaks in the system were not the source of the water in the charge of ammonia.

Naturally, the next thing on the program was to condemn the brand of ammonia they were using as the cause of the trouble. Several different brands were then used with about the same result. Evidently the trouble was not with the ammonia itself.

When this plant was overhauled (the condensers were to be replaced and enlarged), it was discovered that the condensers were built of pipe galvanized on the inside; the liquid lines were also of pipes galvanized on the inside.

The plant in question was old, and sometime previous to this trouble with the ammonia charge (which extended over a considerable period), the pipe work, including the condensers, had been overhauled and replaced where necessary by the local steamfitter, who had used pipe galvanized both inside and outside.

When the liquid receiver was opened up, during the last overhauling, it was found to contain 3 or 4 in. of a white dust resembling minute flat scales; this material was lying packed solid on the bottom of the receiver as shown by the sketch.

On opening up the evaporating coils in the ice tanks, similar dust was found in small quantities in the 4 bottom rows of pipe (bottom feed).

When the condensers were dismantled the pipes were examined on the inside and they were found to be almost devoid of any galvanizing except a small patch here and there which, judging from the looks of it, was just about ready to peel off.

The disintegration of the ammonia was naturally laid to the galvanizing peeling off the pipes and forming a chemical combination with the ammonia, causing this foreign liquid or water in the system. Whether the galvanizing was the cause of this trouble or not is an open question, and I think a problem for a chemist to solve.

U. S. Civil Service Commission announces an examination on Aug. 8, for senior highway engineer to fill vacancies in the Office of Public Roads and Rural Engineering, Department of Agriculture. The duties will involve superintending the construction of roads of various types throughout the United States and cooperating with State highway departments. In addition, the employes will be called to inspect roads and investigate road-building materials, administrative organization and methods of management; inspect roads locally, and give advice in regard to their improvement, etc. The salaries range from $2200 to $4000 a year. Competitors will not be assembled for examination, but should at once apply for Form 1312, stating the title of the examination desired, Senior Highway Engineer (Male), to the U. S. Civil Service Commission, Washington, D. C.

On the same date there will be held a civil service examination for structural steel draftsmen, to fill vacancies in the Bureau of Yards and Docks, Navy Department, Washington, D. C., at salaries ranging from $4 to $8 a day, duties requiring practical experience and ability in the design and construction of structural steel and reinforced concrete buildings, roofs, wharves, etc. Applicants must have reached their twenty-second birthday on the date of examination. Apply for Form 1312.

Flywheel Bursts

LOOSE KEY IN GOVERNOR CAUSES RUNAWAY

ON the morning of June 27, about 4:45, while carrying about half load, a 22 by 42-in. Corliss engine operating at a normal speed of 85 r.p.m. in the central power plant at Natchez, Miss., suddenly began to race. The engineer on duty at the time attempted to close the throttle, but seeing the engine gaining such terrific speed he jumped through a nearby window as the wheel went to pieces, and barely escaped serious, if not fatal injuries.

Figure 1 shows the wrecked engine and part of the plant, the photograph was taken about 3 hr. after the accident, and some of the smaller wreckage had been removed.

Service was restored on all lines about 20 min. after the accident, as no damage was sustained by the other units.

The most remarkable thing about this wreck was

FIG. 1. ENGINE ROOM SCENE AFTER WRECK

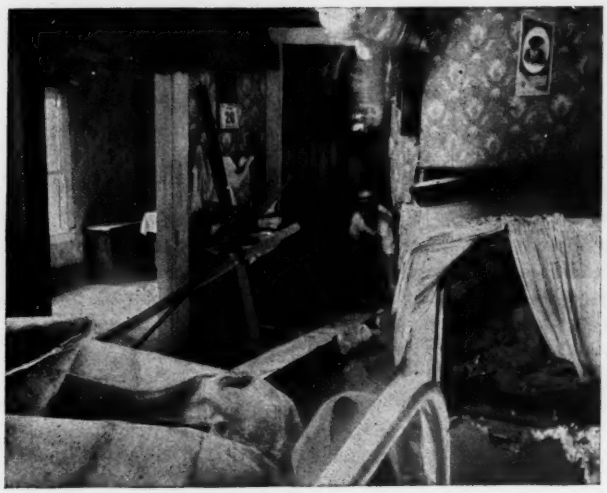


FIG. 2. LOCATION OF FRAGMENT WHICH DID DAMAGE TO RESIDENCE

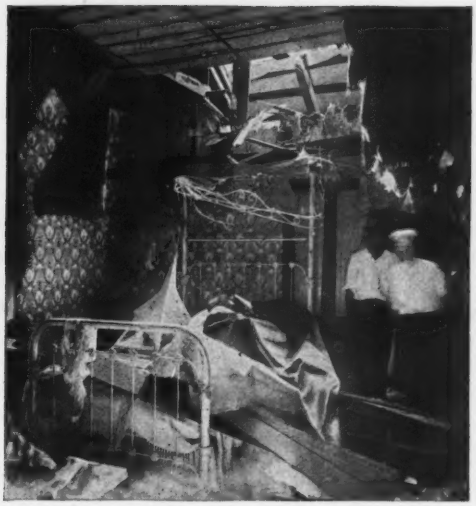


FIG. 3. CANOPY OF BED STRUCK BY FRAGMENT OF FLYWHEEL

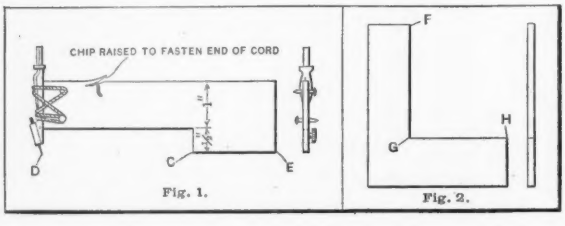
the fact that no one was hurt, several pieces weighing over a ton each were found in the yards of nearby residents. One piece, shown in Fig. 2, which the boy has his hand upon, was hurled a distance of 100 yds., barely missing the cone of a 2-story house, but carrying away its chimney before crashing through the roof of a smaller dwelling next to it. This piece weighed about 1500 lb. After going through the roof it struck the iron canopy of the bed shown in Fig. 3, in which a mother and 3 children were sleeping. This canopy perhaps saved their lives, as it deflected the piece, which struck the fireplace, demolishing it, and finally stopped after it tore up the floor and buried itself in the ground under the next room. Another piece equally as heavy was thrown about 50 yd. further and landed in an open field. One of the spokes, weighing about 500 lb., knocked a hole through a 17-in. wall over the switchboard, and not being able to get through, fell behind the board without doing any damage, except blowing 2 fuses, having fallen across a pair of lightning arresters in its descent.

The entire engine is considered a total wreck, having been wrenched to pieces all over. Flywheel insurance was carried, which will cover the loss fairly well. The runaway was caused by a key coming out of the governor rocker arm.

Method of Drawing an Ellipse

A METHOD of drawing an ellipse is described in the following. In using this method, it is necessary to know the major and minor axes of the ellipse which is to be drawn and with this knowledge, a piece is made of the form shown in Fig. 1. Thin wood is satisfactory for this purpose, a piece of an old cigar box being as good as anything. Referring again to Fig. 1, the distance *CD* is ½ the minor axis of the ellipse, while the distance *DE* is ½ the major axis. It will be evident that the point *D* consists of the pencil holder of an ordinary draftsman's compass, which is secured to the end of the tracing arm in the manner shown.

From another piece of the same wood, a piece is made of the form shown in Fig. 2, the distances *FG* and *GH* being just a little longer than the distance *CE*, Fig. 1. In starting to draw the ellipse, the first step is to lay out 2 lines which intersect each other at right angles, as shown in Fig. 3. The square illustrated in Fig. 2 is then held with the fingers of the left hand so that its inner edges coincide with the center lines which have been laid out. The tracing arm is then held vertically with its corner, *E*, in close contact with the corner, *G*, of the square, and the side, *CE*, flush against the side, *FG*, of the square. Then, by drawing the corner, *E*, along the side, *GH*, of the square while the corner, *C*, is kept in contact with the side, *FG*, the pencil point will trace ¼ of the required ellipse, as shown in Fig. 3. The remaining ¾ of the ellipse is formed by simply turning over the square and repeating the operation 3 times.



FIGS. 1 AND 2. PARTS OF ELLIPSE DRAWING INSTRUMENT

Reference to Fig. 3 will doubtless make this method quite clear to the reader. If, for instance, an ellipse with a major axis of 10 in. and a minor axis of 4 in. is required, the distance, *DE*, Fig. 1, will have to be 5 in. and the distance, *DC*, 2 in., while the length of the legs, *FG* and *GH*, of the square (Fig. 2) will have to be about 2¼ in. The description may sound a trifle complicated, but after trying this method, the reader will be convinced that it is in reality quite simple. In order to get satisfactory results, the sides, *FG* and *GH*, of the square, must be as smooth and straight as possible, and the corners, *C* and *E*, of the tracing arm, should be sharp and clean, so that they will slide smoothly on contact with the square. Those requiring a more permanent form of instrument will easily be able to devise a more stable method of holding the tracing point, and also means for varying the distance, *CE*, by making the tracing arm shown in Fig. 1 of 2 adjustable pieces which can be locked together in the required position. Where it is required to lay out an ellipse on a metal surface, it will be evident that the pencil point must be replaced by a scriber of suitable form.—A. W. SCHOOF, in Machinery.

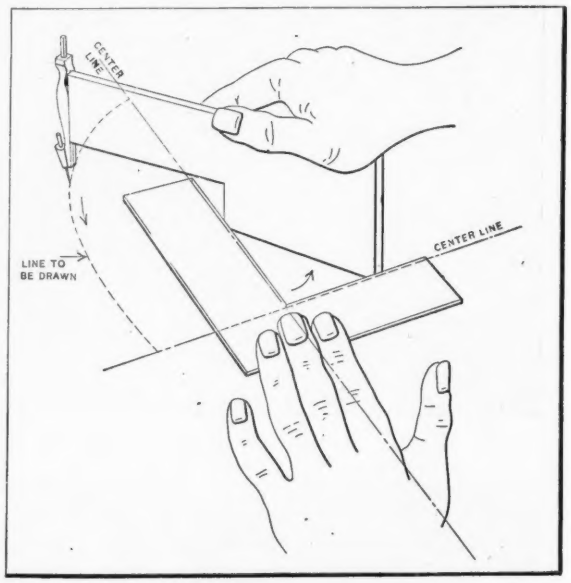


FIG. 3. METHOD OF DRAWING ELLIPSE

U. S. CIVIL SERVICE COMMISSION announces examinations, Aug. 15, as follows: (1) Aeronautic draftsman, to fill a vacancy at the Aeronautic Station, Pensacola, Fla., Navy Dept., at $5.04 a day; (2) electrical draftsman, to fill several vacancies in the New York Navy Yard at $3.52 to $6 a day. Apply for Form 1312, stating the title of the examination for which the form is desired.

Lubricating Oils*

DESIRABLE CHARACTERISTICS AND METHODS OF TESTING. BY A. H. GILL

SUMMARIZING the commonly desirable characteristics of a lubricant, they are:

1. The oil should possess cohesion.
2. It should possess the maximum possible adhesion.
3. It should be as far as possible unchangeable.
4. It should be commercially free from acid.
5. It should be pure; that is, it should be what it purports to be.

The first test which we will discuss is the viscosity test, which is used to measure the internal friction of the oil. This test is of value because a lubricant is really used to keep a shaft or journal and its bearings apart. The journal really revolves on a sheet of lubricant, an action which has been described as revolving on the molecules of the lubricant. The ease with which the molecules of the lubricant slide over one another therefore determines, to a certain extent, the friction loss in a bearing.

The measurement of viscosity of lubricating oils is in a certain sense unsatisfactory because the results obtained with the different instruments which are available for making this test do not agree among themselves. It is therefore customary to state the instrument which was used in determining any quoted viscosity.

One of the most commonly used viscosimeters is the so-called Sayboldt instrument. This is a pipette type, having a tall and rather small diameter pipette immersed in a jacket which may be used for maintaining any desirable temperature during the test. The test is made by filling the pipette to a certain point and noting the time of efflux. The time of efflux is then spoken of as the measure of the viscosity of the oil tested; or the so-called specific viscosity may be determined by dividing the time required for the efflux of the oil by the time required for the efflux of the corresponding volume of water.

The instrument most commonly used in Germany, and now coming into rapid use in this country, is known as the Engler viscosimeter. This differs from the Sayboldt, principally in using a shorter pipette of larger diameter. It is used in the same way as is the Sayboldt, but the specific viscosities as determined by the 2 instruments do not agree.

None of the commercial viscosimeters really measure the viscosity, because it can be shown that the tube through which a jet is discharged must have a length of from 175 to 200 times the diameter to give the true measure. Any of the commercial instruments can, however, be standardized by measuring the times of efflux of standard solutions of cane sugar or of glycerin. By such means the readings of these instruments can be interpreted in terms of absolute viscosity in dynes.

The viscosimeters just mentioned are all of the efflux variety, but there are numerous other forms available. The retarding effect exerted on a paddle revolved in a viscous liquid may be used as a measure of the viscosity and is so used with varnishes, glue and paste. Another form consists of a cylinder suspended from a torsion wire. The retarding effect upon this cylinder when swinging back to normal position after a displacement can be used as a measure of viscosity.

There is really no satisfactory test of the adhesive quality of a lubricant. It is commonly supposed to be determined by a friction test. The test is made by measuring the frictional resistance offered to the rotation of a standard journal in a standard bearing when lubricated with the oil in question. The results obtained with this test depend partly upon the viscosity of the lubricant and partly upon its adhesiveness. Modern research shows that viscosity tests show about as much as do friction tests, but this is not necessarily so and must not be assumed to be universally applicable.

A third test, and one which is of great importance, is known as the gumming test. This is particularly applicable to petroleum oils and is used to indicate the extent to which the oil has been refined. It serves indirectly to indicate the extent to which the oil may be expected to change due to oxidation, when in use.

This test is made by putting a small quantity of the oil to be tested in a small glass vessel, such as a cordial glass, and then pouring upon it an equal quantity of nitrosulphuric acid. A properly refined oil will show very little, if any, change, but a poorly refined oil will be indicated by the separation of large quantities of material of dark color. This color is due to the oxidation of the tarry matter contained in the lubricant. Experience has shown that oils containing large percentages of tar absorb the most oxygen, that is, they are mildly drying oils.

The results obtained by the gumming test agree very well with carbon residue tests made by distilling to dryness in a glass or a fused quartz flask. The carbon residue test has been found of great assistance in choosing a satisfactory cylinder lubricant for gas engines, as a large amount of carbon invariably means trouble in the gas engine cylinder. The lowest carbon content determined by the author was 0.11 per cent. The oil giving this test showed no tarry matter when tested with nitrosulphuric acid. In general, a gas engine oil should not contain more than 0.5 per cent carbon as determined by the carbon residue test.

Checking for safety, that is, the flash and fire test, must be made on lubricating oils.

It is advisable to include an evaporation test with the flash test of lubricants. The evaporation test is made by exposing about 0.2 of a gram of oil at a proper temperature and determining the loss by weight in a given time.

The flash test is made by heating the oil slowly in a vessel surrounded by a proper bath and determining the lowest temperature at which a flame passed over the surface will ignite the vapors which are given off.

It is generally conceded that lubricating oils should be practically free from acid, and the so-called acid test is made to determine the extent of acid content. The mineral oils are agitated with sulphuric acid during

*Address delivered before the Detroit Engineering Society.

the refining process for the purpose of removing tarry materials, and this acid must be practically entirely removed from the oil before it is put on the market. Oils may become contaminated with acid from another source as well; namely, the animal or vegetable oils which are occasionally mixed with them for the purpose of modifying their characteristics. A content of 0.3 per cent of acid is generally considered the maximum allowable.

It is often desirable to determine the character of the raw material from which a given lubricating oil is made. This can be done in the case of oils refined from petroleum by means of the specific gravity test. Experience has shown that lubricants made from petroleum with an asphaltic base ran from 7 to 10 deg. Baume heavier than similar lubricants made from petroleum with a paraffin base.

In examining oils, it is well to bear in mind that the viscosity is easily increased by the use of a material known as oil pulp or oil thickener. This is really oleate of alumina, and while it brings up the viscosity, it does not give the greasiness expected when that particular viscosity was specified. At ordinary temperatures, a very small quantity of this material will enormously raise the viscosity.

There is another test, known as the cold test, which is of great value in some cases. If an oil is to lubricate a bearing, it must be fluid enough at the temperature of use to flow readily into that bearing. Many ruined bearings have resulted from the use of an oil which became too viscous to flow under the conditions of use. For such reasons, it is customary to chill samples of oil and to determine the temperatures at which they become too thick to flow readily.

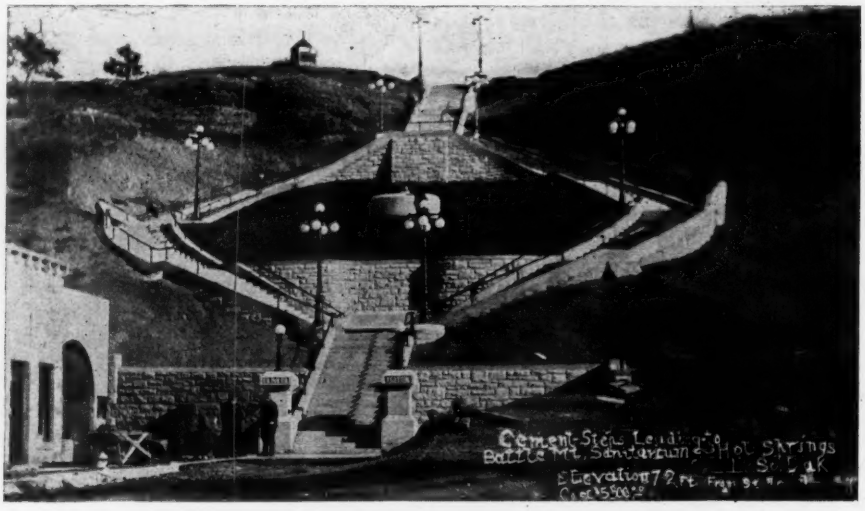
It is a very simple matter to determine the presence of petroleum oils in mixture of oils with animal or vegetable origin. This is done by saponification, which serves to separate the petroleum oil, which does not saponify, from the others which do.

There is a comparatively new test, known as the Maumene test, which gives results comparable with those obtained with the iodine test, but is much simpler and therefore more readily performed by the average individual. For this test, 50 grams of oil and 10 c.c. of sulphuric acid are placed in a beaker and slowly heated. The maximum temperature rise which occurs during the subsequent distillation is noted and used as an indication of the character of the oil.

No rigid directions can be given for the choice of oils for given purposes. It is best to try various lubricants which can be purchased for any given lubricating problem until one is found which gives satisfactory results. This should then be very completely tested and the results of the test should be used in writing specifications on the basis of which bids are to be asked. When the problem is handled in this way, the different prices asked for lubricants which will meet the same specifications will often be found most remarkable.

Engineering in a Sanitarium

THE illustration herewith, which is a view of some work done by one of Practical Engineer readers, John S. Goodrell, of Hot Springs, S. D., shows the field which is often covered by the man in charge of power plant and mechanical equipment.



STAIRWAY LEADING TO BATTLE MOUNTAIN SANITARIUM GROUNDS

Mr. Goodrell is chief engineer of the Battle Mountain Sanitarium, a great institution maintained by the government for the benefit of old soldiers and sailors. He has all the mechanical as well as civil engineering and architectural work to do for the sanitarium, and the photograph shows the latest work that he has completed, a new stairway leading from National Ave. to the Sanitarium grounds 80 ft. above. The steps are of reinforced concrete, carried on stone horses, having a flight of 24 steps from the street level to the lower side of the ellipse, and another straight flight of 52 steps from the ellipse to the sidewalk level on the Sanitarium grounds. The treads, which are 10 ft. long, are connected by expanded metal running into the curb. The whole structure is certainly a work of art and a credit to the engineering profession. The cost for material and labor was $5500.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Reducing Power Station Stores

THE PACIFIC POWER & LIGHT CO., operating in Oregon and southern Washington, has inaugurated an interesting competition among its branch managers to encourage the reduction of stores at the various local substations. The contest is operative upon a percentage plan with relation to the amount of material in store and the annual gross earnings during the company fiscal year, dating from March 1.

The amount of stores at the different branches on Sept. 30, 1915, and March 1, 1916, represented in percentages of the annual gross earnings of the respective branch as noted below, will be used as a base in determining the average at the close of the year.

Branch Station.	Percentage of Annual Gross. March 1, 1916	Sept. 30, 1915
Astoria	5.1	5.01
Dayton	12.4	13.7
Goldendale	16.4	18.5
Hood River Gas & Elec. Co.	9.6	....
Lewiston	26.0	31.5
North Yakima	8.2	8.62
Pasco	3.2	3.37
Pendleton	3.5	5.0
Pomeroy	16.9	19.3
Prosser	11.2	8.9
Sunnyside	12.3	12.4
The Dalles	12.8	13.4
Toppenish	5.9	6.2
Vancouver	23.0	24.8
Walla Walla	6.7	6.55
Walla Walla Valley Ry.	10.4	11.8
White Salmon	16.6	31.3

Similar computations on a like basis will be figured at the close of November and December, 1916, and January, 1917, and a general average obtained. The manager of the branch station showing the highest proportionate reduction will receive a cash prize which, of course, is attended by an added distinction, beyond the prize, as an award of efficiency. L. R. W. ALLISON,

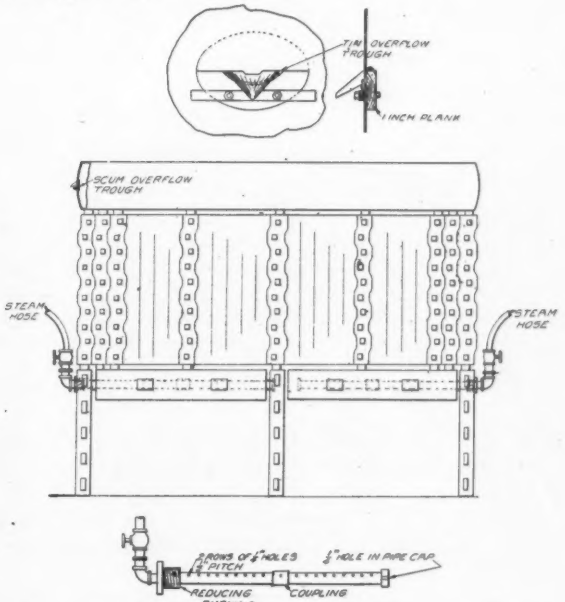
Removing Oil and Grease from Water

IN PLANTS where forced lubrication is used on engines and auxiliaries, grease and oil may sometimes work their way to the boiler plant.

When a film of oil or grease fouls the interior heating surface of the tubes, it not only reduces the evaporative efficiency of the boilers, but places the boilers in an unsafe condition for steaming, and must be thoroughly cleaned off as soon as possible.

The following is the method used to clean 8 B. & W. boilers in a plant of 16 under my direction, which became badly fouled with grease; saving of time being a necessary element combined with economy.

The 8 boilers were emptied and the manhole covers removed, and 8 sets of ½-in. piping, made as shown in the sketch, with the necessary pipe fittings, were introduced into the lower front crossboxes at the right and left sides as shown in sketch. There is a screw plug in the corner uprights, placed there for introduction of tube expander mandrel, which plugs were removed and these sets of piping inserted through them into the crossboxes; the hole being standard, a reducing bushing is used.



PERFORATED STEAM PIPE AND METHOD OF USE FOR CLEANING BOILERS

Fill the boiler to the top row of 2-in. tubes with water. Dissolve 175 lb. of a good boiler compound and pour it in equal parts down each header from inside of boiler drum. Make a half manhole plate of wood for each boiler, as shown in sketch, bolt in place, and turn steam on to crossboxes for boiling.

The arrangement of this piping produces the same circulation as when the boiler is steaming.

As the water boils and condensate forms, the level will rise until it overflows the half manhole. The oil and scum will rise with the circulation of the water and flow off the top with the excess water.

Twenty hours' boiling gave the best result. When finished boiling, the manhole plate was removed and the

boiler manhole plate replaced; a pressure of 40 lb. was then applied in the boiler and the steam shut off; all bottom blow valves were opened wide and the boiler emptied.

A few plates were removed at staggered intervals and the tubes were found to be in clean condition.

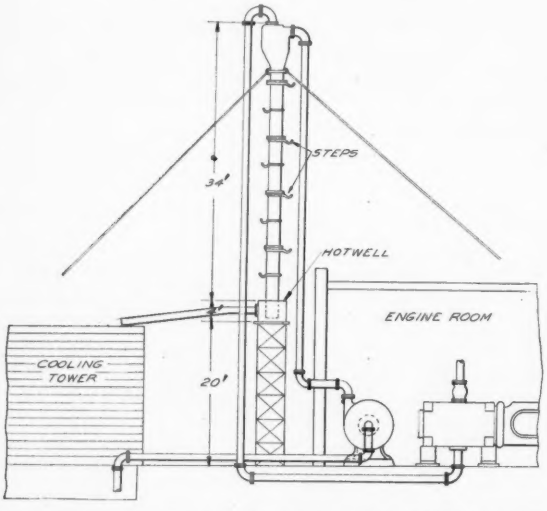
The time averaged for each boiler was 44 hr.

All 8 boilers being treated at the same time, the plant was again ready to carry its load in 2 days' time.

C. H. W.

One Pump for Condenser System

THE ACCOMPANYING sketch shows how an engineer solved the problem of having to pump the cooling water only once for a 250-hp. engine. From the ground to top of condenser is 59 ft. It is held in place by 4 guy wires.



ARRANGEMENT OF ENGINE, CONDENSER AND COOLING TOWER

The hotwell is a tank 3 ft. in diameter and 4 ft. deep supported 20 ft. above the ground by 4 supports well braced.

The water flows from the hotwell to the top of cooling tower. A centrifugal pump forces the water to top of condenser.

L. K.

Packing Rules

ON PAGE 424, May 1 issue, a reader states that by using packing adapted to the service and following the manufacturer's instructions, there should be no troubles such as are often related.

Let me give some personal experiences along this line. In a certain plant there was a 14-in. hydraulic accumulator having a vertical travel of 14 ft. This accumulator was packed where it slid on the ram or column with 7 coils of ¾-in. packing. For almost 3 yr. this system worked at a pressure of 1000 lb., and at that pressure we had little trouble to hold this packing fairly well, using square braided flax at 38 to 45 cents a pound.

It became necessary to increase the pressure on this system, and so the accumulator was weighted some more until we had 1500 lb. per sq. in. on the line. With this higher pressure the flax would not hold at all. We then tried a "waterproof hydraulic packing" made from long fiber flax of extra good quality. We tried 2 different kinds of this packing, one at 90 cents a lb., the other at $1.25 a lb. These were not much better than plain flax at 40 cents a lb. As a sort of experiment we packed this accumulator with one ring of ordinary ½-in. air hose, then 6 rings of waterproof hydraulic packing, and to my surprise this held fine for several weeks, and we continued to pack after this style, several times. Then a traveler came along and advised us to try a hydraulic packing that the catalog write-up stated would withstand a pressure of 5000 lb. per sq. in. We ordered a set and followed instructions to the letter, and it was no good at all. It never held water-tight, wore out in a few days, and cost $56.

We then went back to the hose and waterproof hydraulic scheme, until another traveler told us of his line of fiber rings and metallic packing in alternate rings. We gave his a trial and he told us of accumulators just like ours, working on the same identical pressure and his packing had been in for 2 yr. and was still holding fine; also, of other places where they would not use any other style or make of packing. We took this stand: We are willing to try it out and if it is as you say, we are a customer. We tried it out, with no better success than we had with the other special material.

One day a man came in to see the accumulator we could not keep packed, and it happened just then to be doing very well, for it had just been packed a few days before. He asked what trouble we had, and I explained as fully as I could just what trouble we had. He said he could hold it with rawhide, so I told him of our experience with rawhide on the plungers of the hydraulic pumps, working at the same pressure.

"Well," he said, "is that accumulator ram true?"

I told him that it surely was, also that the bottom of the packing box was a good fit on the ram and that the gland was also a good fit both in the packing ring box and on the ram.

The result was that he sent us a supply of ¾-in. braided rawhide packing, with instructions to pack accumulator with: 1st. 1 ring of cotton duck packing. 2nd. Use the rawhide to fill up the packing box. 3rd. Finish with a ring of cotton duck packing. Do not set up too tight on the gland follower nuts.

This was done exactly according to instructions, and the results were a surprise to me. After 3 weeks' service of 24 hr. a day, except Sunday, the packing was holding absolutely water-tight and a reasonable one-man effort on the wrench only, got ¼ turn on the follower nuts. So it goes to show that, even following instructions with goods recommended by the manufacturer, one can often be misled or deceived.

Upon another occasion, we bought packing from a company for an outside, end-packed boiler feed pump, pumping hot water. Here is the record from my note book of tests:

Oct. 13, 1913. Packed boiler feed pump No. 1 with "trade name" packing. Used 4 lb. at $1.75 per lb.

Sept. 16, 1914. Had to remove plunger from one side of pump for repairs to plunger; on account of this, also that bottom of one packing box is not in the best condition, new packing will be used for this one box. The other packing box will be packed with the old packing that was put in on Oct. 13, 1913. Packing on other plunger is doing fine.

May 10, 1915. Packing of Oct. 13, 1913, leaking considerably. Examined, and find it advisable to repack pump with new packing of same make.

This pump was in service 24 hr. a day every day except a few hours to examine valves, also to make the repair to the plunger as noted. Pump was supplying water to 2 280-hp. water-tube boilers.

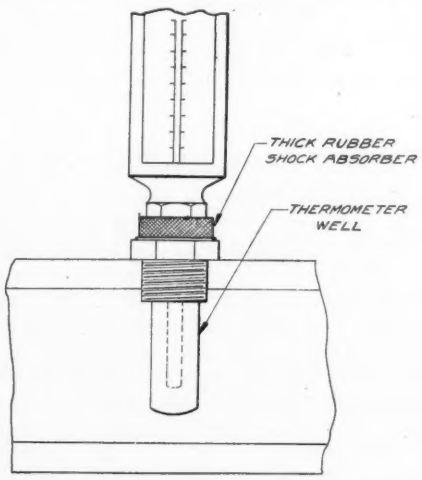
Upon another occasion, I packed the water pistons of an inside packed type duplex pump with square braided flax. This pump handled cold water at an average pressure of 80 lb. per sq. in. This packing did a total of 9672 hr. of continuous service.

Personally, I have found hydraulic service with pressures above 1000 lb. per sq. in. the most difficult to hold. Pipe line joints are no trouble whatever to make up, but pump plungers, accumulators, press rams and pistons are each and all liable to fool the best packing concern in the country, and I have tried a host of different makes and combinations and have found none to equal the cotton duck and rawhide as outlined above.

H. W. BENTON.

Thermometer Shock Absorber

THE THERMOMETER which we had installed in our boiler feed line was continually being deranged, and the mercury glass broken, because of the shocks and vibrations in the line. A change in location was tried but proved unsuccessful. We then inserted a thick washer of very soft rubber between the screwed base of the thermometer and the socket well in the pipe line, and the



THERMOMETER WELL WITH RUBBER BUSHING

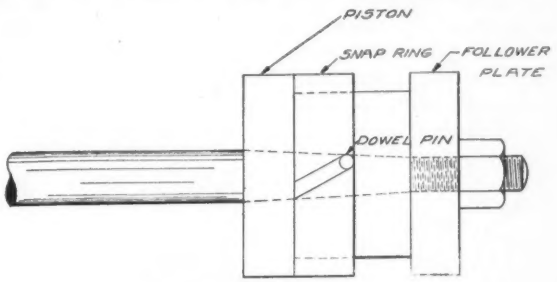
cushioning effect thus produced completely cured the trouble. There was no pressure, of course, on this joint between the well and the thermometer, hence this soft pliable connection was entirely serviceable, while acting as a shock absorber for the thermometer. M. SALLER

Providing Proper Elevator Drive

REFERRING TO "Providing Proper Elevator Drive," page 509, June 1 issue, this speed reduction is unnecessary, as it can be avoided by using a slow-speed motor. While slow-speed motors cost more, are less efficient, and are to be avoided where possible, this is one of the cases where their use is imperative for good lasting results. H. D. W. does not state the horsepower of the outfit, but the higher, the more the need of the slow-speed unit. As a 50-r.p.m. machine would cost considerable, a 600-r.p.m. motor could be used with about 10 per cent greater first cost of motor. The maintenance would be much lower than for a 36 time speed reduction in either 1 or 2 stages. It might be best, if the condition is one of heavy service, to use a standard back-geared slow-speed motor. To determine what is best, it is necessary to have a print of the proposed layout and the horsepower and service conditions. H. E. WEIGHTMAN.

Securing Steady Oil Feed

IN OUR boiler plant, the fuel oil pumps are the ordinary duplex type with brass valves and seats and white metal float rings on the pistons. These float rings wear more or less and the pumps would churn the oil to a certain extent, causing an unsteady flow of oil to the burners. To remedy this I had the machinist turn up 2 snap rings for each piston. After slotting the rings, which were turned a little larger than the bore of the bushing, we stamped them onto a mandrel and trued



PISTON OF FUEL OIL PUMP

them up perfectly round. He then put a dowel in opposite sides of the piston to prevent the rings from working around while the pump is in operation. The rings were then slipped onto the piston and the follower and nut put on. The two rings work against each other, as there are no separate slots for them to work in on the piston. After reassembling the pump it was started up and it worked as smoothly as one could wish, so I think our troubles are over as far as that part of the pumping is concerned. D. J. WOLLAM.

Engineering Hobbies

HOBBIES ARE good things to have, usually.

Men who have hobbies are not "wishy washy." As a rule they are consistent fellows.

For instance, an engineer of my acquaintance has a good hobby; he reads a good engineering publication regularly from cover to cover.

He keeps a clean table expressly for the latest number. Nothing is ever permitted on that table save last issue of the journal.

As soon as a new issue reaches his desk, he takes it to the table, removes the "old" issue which he puts away on a shelf above the table with the other old ones and places the new issue in the usual place.

During his spare moments, he sits at that table and reads that issue. He begins at the front cover, looks over all of the advertisements and reads those that are of interest, and he reads "everything" on the editorial,

news and descriptive pages. After finishing that, he proceeds through the remaining advertisements and the publication is finished.

He leaves it on the table, though, and from time to time he returns to the journal and re-reads the parts that he wants to remember. In that way he keeps strictly up-to-date in his profession.

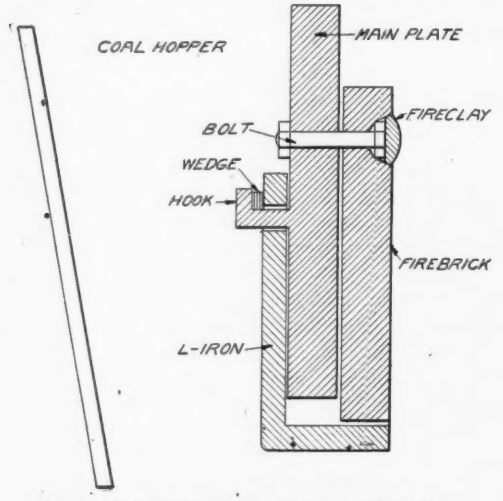
His boss, of course, knows of this hobby, and he approves of it. The boss is certain that his engineer "knows what he talks about," for there upon that table lies the invariable "latest."

His friends and assistants also know of this hobby and they, too, approve of it. They know where the latest issue is always to be found.

Go get a hobby. If you like this one, take it—it's yours. N. G. NEAR.

Repairing a Stoker Head

THE ADJUSTABLE gates or heads for chain grate stokers used for controlling the thickness of the bed of fuel on the grate are sometimes constructed of rows of firebrick. Each brick is held in position by an L-shaped iron. The foot of the ell passes under the brick and the iron itself is fastened to a heavy steel plate which is a part of the stoker head. This plate is itself the front of the coal hopper and extends across the stoker. The L-irons are held in place by wedges but the pressure of



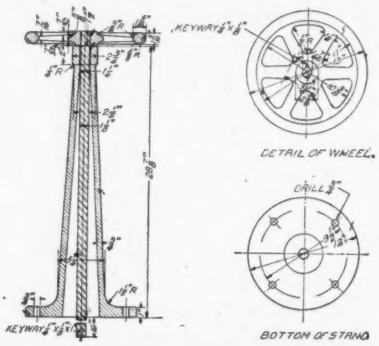
VERTICAL CROSS SECTION OF STOKER GATE

coal against them frequently cause them to work loose. Or if the load on the boiler is light or intermittent and the grate is slowed up, there is a tendency for the fire to creep back toward the stoker head and even into the hopper. This heats up the foot of the L-iron holding the firebrick causing it to warp and sometimes to break off. If the iron bends, breaks, or loosens, the brick settles into the bed of fuel and may drop out entirely. This can be remedied by drilling through both brick and plate, inserting a common bolt and countersinking the head. The bolt can be protected by cementing the hole over with fireclay. The iron ells should be left in place to take the pressure of the coal from the brick. This makes a very satisfactory construction. The accompanying sketch shows the method.

Homemade Valve Stand

RECENTLY, while looking over some old drawings, I came across the drawing of a valve stand which the article, Homemade Floor Stand, by Mr. Saller, appearing on page 505 of the June 1 issue, called to my mind.

Some years ago, while taking a course in mechanical drawing, I made it a point to measure, sketch and make drawings of many objects found about the plant. The



SECTION AND DETAILS OF VALVE STAND

valve stands over the exhaust valves were among them. The valves were 8 in., located below the floor and operated from the stand through a bevel gear on the stem. The accompanying drawing shows all parts of the stand in detail with dimensions and finish.

I am submitting this not as an example of drawing, but with the idea that it might be of interest to Mr. Saller and other engineers wishing to make a stand of this kind. J. C. HAWKINS.

Cost of Homemade Floor Stand

THE IDEA of M. Saller, on page 505 of the June 1 number, is fine, except for one thing. If he will check up the cost of the parts as he has the device built he will find that it will cost him several times as much as the regular floor stand for sale by several companies. The regularly manufactured article is also better fitted to the task. Before advising "homemade" articles, he should see what they will cost. To use his method, even if the parts were already at the plant, would be a waste of money. Have him check the costs at net prices in any standard catalog. H. E. WEIGHTMAN.

Pump Valve Seat Patented

THOMAS GRISENTHWAITE, of Fall River, Mass., calls attention to the fact that the pump valve seat construction described in the July 1 issue, on page 583, is a form patented by him, and that the description was sent in by someone who had seen his valve seat. Valve seats of this construction can be obtained from Mr. Grisenthwaite on reasonable terms

U. S. CIVIL SERVICE COMMISSION announces an examination, Aug. 22, for mechanical draftsman to fill vacancies as they may occur in the Office of the Chief of Ordnance, War Department, Washington, D. C., at entrance salaries ranging from $1000 to $1200. Age, 18 yr. or over. Apply for Form 1312.

Successful Kinks From The Plant

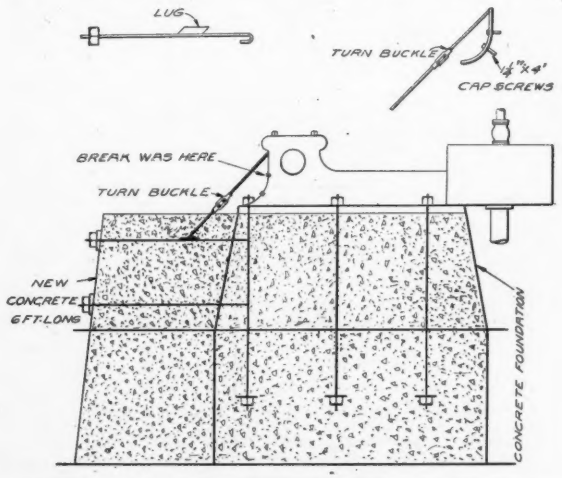
For Saving Time, Work and Trouble

Repairing Broken Frame

FINDING THE engine frame broken back of main journal as indicated in sketch, I put laborer to work clipping off back of concrete foundation that was oil soaked and also had some excavating back of foundation done. Then I had some holes drilled in the foundation about 8 in. square and made anchor rods with a hook on one end to hook over the old anchor rods to stiffen the new work. These upper anchor rods had a lug welded on one side to hold radial or angle braces.

While the men were pouring concrete, I was bending 2 1½ by 2¼-in. straps to fit back of the main journal which I put on at the bottom of the bed with 1¼ by 4-in. cap screws. I also had the machinist making 2 solid turnbuckles, one for each brace. I might add that we rigged up a gas oven on the job to bend the straps to fit the main journal end of the engine bed. After concrete was poured, we lowered the shaft in place, set our braces and waited for concrete to set. In 80 hr. after we went to work the engine was again under steam and not a quiver was felt, and it has been operating 7 yr. since without any sign of giving way.

FRED V. BROADAWAY.



METHOD OF REPAIRING BROKEN FRAME AND DETAILS OF REPAIR PARTS

Engine Oiling

HAVING HAD CHARGE of overhauling various sizes and makes of engines, I have found some in which the designers had used very poor methods for oiling. For instance, having charge of 2 50-hp. vertical compound condensing engines on which the crossheads were oiled as shown by Fig. 1, the brasses and pins would wear excessively and needed to be set up rather frequently, this was not all, as the pins would wear so that they would have to be trued up. This, of course, meant that there would have to be some shop work which always takes time and puts an engine out of commission for a day or so.

Plenty of good oil was used to try to keep them from wearing that way, but the remedy was found only when the oiling system was changed to that shown by Fig. 2. This was accomplished by taking the piston rods out and drilling the foot of rod and cap brass as shown; an oil cup was made and fastened as illustrated, the oil being led by small tubing to the pin. This cup was made so that the oil would have no tendency to fly out of the cup when the engine was making the downward stroke, as it was wont to in the old style cup. There was plenty of clearance space between crosshead and cylinder head.

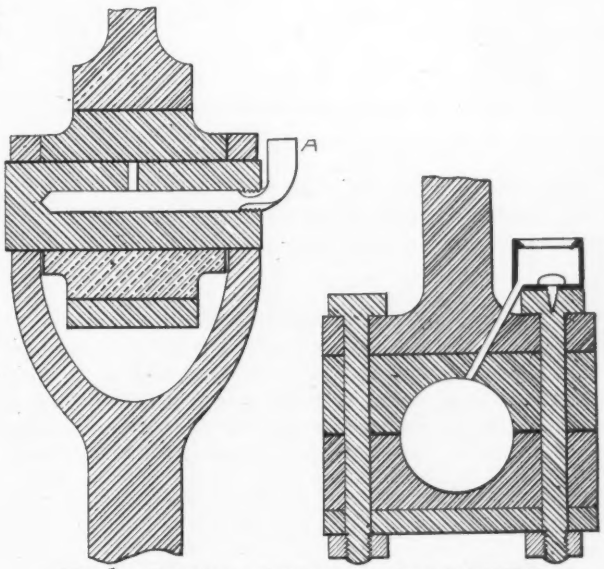


FIG. 1. ORIGINAL METHOD OF OILING CROSSHEAD
FIG. 2. REVISED ARRANGEMENT FOR OILING CROSSHEAD

After fitting both engines as shown, there was no more trouble of pins running hot nor did I have to set up on them as I formerly had to do every few days. They have now been running for some time and there is not the slightest sign of wear, and they have not run warm once.

It will readily be seen that the old system would require a lot of oil to fill space before there would be any touching the wearing surface and then, if brasses were set up close, there would be an air pressure that

would keep the oil from coming in contact with the surface of the pins. Much oil was lost, as it will ooze out at the pin ends when the brasses are not fitted properly and I have fitted brasses as shown by Fig. 3, with good results. This cut shows how the edges of a brass act as retaining rings and all oil will have to stay in the clearance space except that which will wear its

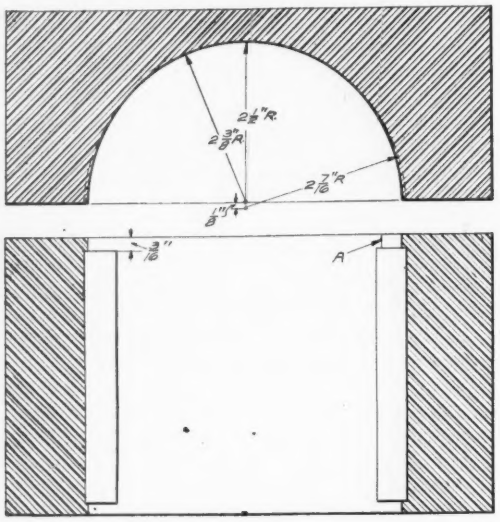


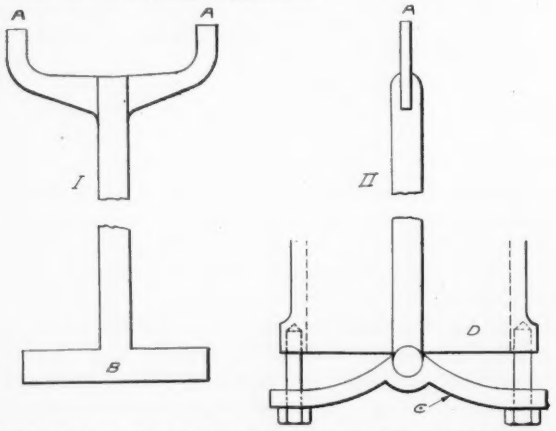
FIG. 3. BRASS WITH OIL SPACE PROVIDED

way through, when this space is not kept closed, the oil will have a free passage to the end of pins and it will take so much more oil to keep the pin running right.

F. W.

Using Special Wrench to Hold Piston

TO PREVENT the pistons and rod from turning while removing lock nut and follower, to repack or tighten packing on plunger in Marsh pumps or other pumps where a wrench cannot be used on the rod, and enable one to do the work where two are usually required, I offer the following suggestion:



WRENCH AND CLAMP USED TO PREVENT PUMP PISTON FROM TURNING .

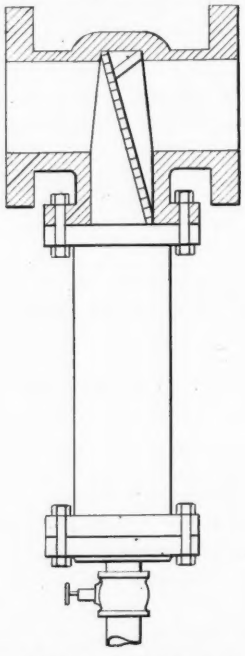
The wrench furnished with pump is shown at I; A are points which engage slots in steam piston; B, tee handle on wrench; D, steam cylinder; C, piece of 1¼ by 2-in. strap iron bent to fit handle of wrench and holes drilled to accommodate 2 stud bolts on the steam end. Place the wrench in the slots, C over wrench and by screwing on nuts with a little tension, the piston will not turn while working on the plunger. Anyone who has use for this and can not bend and drill iron as shown, can use a piece of hard wood instead, or in case of a broken wrench, can use a piece of board between piston and clamp C, as this holds the piston firmly against the back piston head. O. BROWNING.

Homemade Strainer

AT ONE of my former plants, at certain times of the year, we experienced considerable trouble on our water circulating lines because of clogging from rubbish, twigs, etc., drawn in with the suction from the river.

At the time, it was impossible to secure appropriation for the purchase of one of the commercial strainers which was needed, so we finally rigged up a homemade makeshift affair which temporarily served the purpose.

This strainer was made of an old gate valve body taken off the scrap heap. The bonnet of the valve was taken off and a well or pocket made by means of pipe



STRAINER MADE FROM GATE VALVE AND PIPE FITTINGS

and flanges, with a blowoff connection at the bottom. Then a piece of heavy sheet metal, perforated with ½-in. holes was placed in the valve body to prevent the foreign matter from passing on along the line. This strainer plate was so inclined in the valve body that it had a tendency to deflect the twigs, etc., into the well which was of sufficient size to hold them until the strainer could be cleaned by removing the companion flange at the bottom. M. A. SALLER.

KEEP YOUR NEW FILES for brass, and use them on iron after they have become too dull for brass.—The Gas Engine.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Increasing Duty of Intermediate-Pressure Cylinder

KINDLY CRITICISE the cards shown herewith, which were taken from a triple-expansion marine engine. Those marked A, B and C were taken with full valve travel, while cards D, E and F were taken cutting off by link to 13 in. under usual working conditions. The boiler pressure at the time these cards were produced was 175 lb. gage.

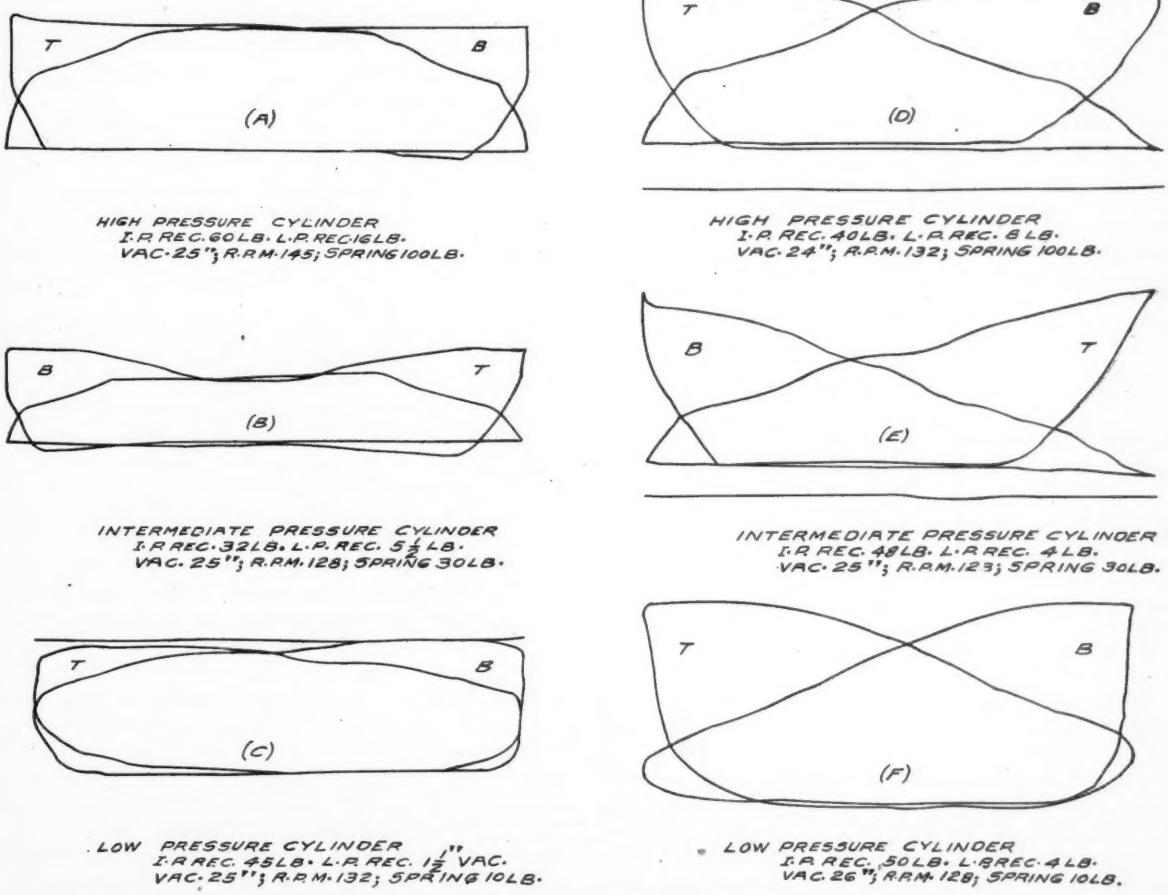


FIG. 1. CARDS A, B AND C TAKEN WITH FULL VALVE TRAVEL; CARDS D, E AND F TAKEN CUTTING OFF BY LINK

Is there any way in which the horsepower developed by the intermediate-pressure cylinder may be raised to equal that of the high- and low-pressure cylinders without changing the valve? H. T.

A. It is difficult to advise definitely on your problem without knowing more of the running conditions, such as valve travel, lap, lead, method of adjusting position of eccentrics (if any) or whether it is possible to adjust the position or length of any of the levers on the rock shaft by which one might make a few minor changes in the valve gear in the forward motion in the interests of better steam distribution, even if it aggravated the trouble in the reverse motion.

The proportion of the cylinders is excellent for the pressure carried, though it appears that the temperature of the cooling water where you are ought to produce a little better vacuum than that shown on some of the cards. This fluctuation may, however, be due to other causes than temperature.

Variations in speed, when the several cards were taken, also complicate matters a little; but where one has

but one indicator, it is almost impossible to have identical operating conditions when changing the instrument from one cylinder to the other.

But throughout all cards, the intermediate cylinder seems to be "lying down" on the job. In Fig. 2 is a comprehensive diagram showing the performance of all cylinders with full travel.

This diagram shows the conditions under which cards A, B and C were taken, the mean effective pressure at both top and bottom, with the average, the indicated horsepower developed, and the receiver pressures.

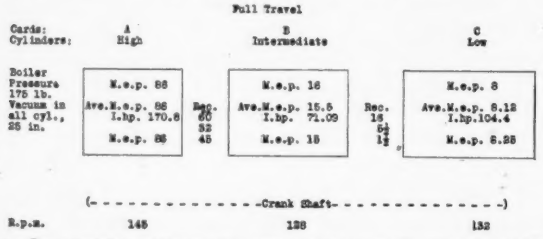


FIG. 2. PERFORMANCE OF CYLINDERS WITH FULL VALVE TRAVEL

Figure 3 shows the conditions under which cards D, E and F were taken, and the top, bottom and average mean effective pressure, the indicated horsepower developed and the receiver pressures.

In both of these diagrams, the indicated horsepower of the intermediate-pressure cylinder is considerably less than the indicated horsepower of either the high- or low-pressure cylinders. In order to place the cylinder performance on a comparative basis, the accompanying diagram has been worked out on a basis of 128 r.p.m., as this seems to be a "happy medium.' It is also assumed that other conditions will remain the same.

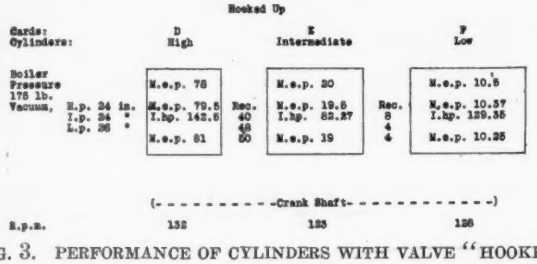


FIG. 3. PERFORMANCE OF CYLINDERS WITH VALVE "HOOKED UP"

You will note that at full valve travel, the high-pressure cylinder does 48 per cent of the work—nearly half—while the intermediate-pressure cylinder does barely 1/5 of it, while the low-pressure cylinder trails along with less than ⅓. When hooked up to cut off at 13 in. (24 in. stroke), the ratio begins to even up a little, especially between the high and the low, the percentage being between 37 and 38 per cent, which is close, but the low-pressure cylinder, while doing more work than at full travel, still does less than ¼ of it.

This brings us down to a point where we have something tangible upon which to form an opinion, and to suggest a remedy for the trouble. And even here it is difficult, inasmuch as receiver pressures differ with the different cards.

While some of the cards scale differently from the figures given for the receiver pressures and the vacuum, yet as a whole they come closer than they usually do under similar conditions. The high-pressure card scales lower than the boiler pressure given; but this is due to a partially closed throttle, or natural drop owing to friction in the steam mains, valves, fittings, etc.

This card shows excellent working conditions and a tight valve. At full stroke, the mean effective pressure (and consequently the indicated horsepower) are the same, both top and bottom; while hooked up, the bottom end is favored a little. This is better than to have conditions reversed.

The low-pressure card, B, is the problem. At full stroke, the pressure drops off at about 10 per cent of the stroke, which materially reduces the power of that cylinder. This is due to the closing of the exhaust valve of the high-pressure cylinder, and as the receiver is quite small (usually but an enlarged pipe connection), there is a natural drop in the steam line from that point on to where cutoff actually takes place. The same peculiarity is present in the low-pressure card, F, only to a smaller degree. This might be accounted for by a longer connection between the intermediate pressure and low pressure, than between the intermediate pressure and high-pressure cylinders, which is probably due to the high-

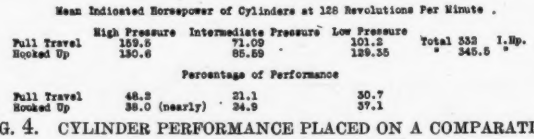

Mean Indicated Horsepower of Cylinders at 128 Revolutions Per Minute.
High Pressure
Intermediate Pressure
Low Pressure
Total 532 I.Hp.
Full Travel 159.5 71.09 101.2
Hooked Up 150.6 85.59 129.35 " 345.5 "
Percentage of Performance
Full Travel 48.2 21.1 30.7
Hooked Up 38.0 (nearly) 24.9 37.1

FIG. 4. CYLINDER PERFORMANCE PLACED ON A COMPARATIVE BASIS; SPEED OF CRANK SHAFT, 128 R.P.M.

pressure cylinder being in the middle, the intermediate pressure forward, and the low pressure aft, which is a common arrangement.

The intermediate pressure card shows a little heavy on top both in full travel and hooked up. Either the valve stem or the forward eccentric rod needs slight adjustment to reverse these conditions, or at least have the load at both ends equal. You might be able to increase the load on the intermediate pressure cylinder in any one of several ways in the forward motion at the expense of the reverse, which is used but a short time at long intervals.

You might add lap to the valve. Just how much would be difficult to say without knowing more of the working conditions, such as valve travel inside and outside lap and advance of eccentric. With these facts at hand you might work out a slide valve diagram such as the Zeuner, from which you could determine with accuracy just how much lap to add in order to produce the desired results. Adding lap, that is, steam lap, will make cutoff earlier, and admission later. In order to bring admission at the right time so as to secure a good blend of the compression and admission lines, the forward eccentric would have to be advanced a small amount.

For constructive reasons, this might not be possible, or if so, the feather key arrangement by which the eccentric may be safeguarded, might not permit much change in the location of the eccentric on the shaft. The intermediate lever on the rock shaft might be shortened a small amount so that in reversing, the intermediate link would not have as much motion as the other 2 links, in which case the slide block would not go clear to the end

of the link at full travel, but would be continually hooked up a small amount, thus causing earlier cutoff in the intermediate, and accomplish to a certain extent the desired result, that of making this cylinder do more work.

The writer has seen compound engines where the receivers proved too small, with results about as shown on your intermediate pressure card, and good results were obtained by increasing the size of the receiver. In one case, the head was removed and a length of cast-iron pipe made for the purpose was inserted and the old head put on the end of this again. In the other instance, where it was not possible to do this, a large T was inserted in the receiver piping in place of an elbow, and a suitable sized drum connected to this by a short nipple, the entire arrangement being similar to a homemade air chamber on a force pump. In fact, in the latter instance, to prevent this drum being converted into a dead air chamber, a pipe connection was run from the back end of it around the original receiver and into the line again just before it entered the low-pressure cylinder, creating a circulation through the drum.

Whether or not this arrangement would be practical in your case, you would have to determine; but care would have to be used to provide drains in any low parts to prevent filling with condensation. G. H. WALLACE.

Proper Voltage for Arc Lamps

I HAVE 4 110-v. arc lamps which, if possible, I would like to operate on a 220-v. circuit. How could this be done? I planned on connecting 2 lamps in series, but this would require more wire. F. P. M.

A. A 110-v. arc lamp will hardly work satisfactorily on a 220-v. line. The only thing that could be done would be to put in a coil of wire with sufficient resistance to take up the extra 110 v. The voltage required at the arc is about 70, the balance of the voltage being used up in the resistances and magnets of the lamp.

As to running 2 lamps in series on a 220-v. circuit, whether this can be done successfully will depend on the regulating mechanism of the lamp. The only way you can tell is to try it.

So far as the voltage and current are concerned, there will be no difficulty, but the trouble may be that the regulating mechanism of the 2 lamps will get to pumping and keep the arc lights flickering all the time.

Whether it will take too much wire to run in this way all depends on the location of your lamps with respect to the supply mains. If the lamps are located directly on the mains, you would, of course, have to run a wire from one lamp to another in order to connect up 2 lights in series, and if the lights are some distance apart, this might mean a good deal of extra copper. The best thing is to try your 2 lamps in series, in an experimental way, and see how it works out. If the operation of the lamps is satisfactory, you can then judge of the wire necessary to make the series connection by the distance you must run between lights.

If these lamps are placed a considerable distance apart, it is probable that you might make some better arrangement by changing with the makers and getting 220-v. lamps in place of 110-v. The 220-v. lamps are arranged to run with a longer arc than the 110-v. lamps, therefore take more voltage at the arc. A. L. R.

Oxy-Acetylene Welding

I HAVE FREQUENTLY HEARD of a compound by means of which it is possible to weld cast iron, or at least join the 2 pieces to make a substantial joint.

Where could I obtain such a compound and directions for its use? F. H.

A. The welding compound which you have reference to is known by the trade name of Thermit, and the Thermit process of welding is controlled by the Goldschmidt Thermit Co., 90 West St., New York City. This process makes use of the great heat produced by oxygen combining with aluminum, and a mixture of finely powdered aluminum with an oxide of iron is the compound employed.

The reaction is started with a special ignition powder, such as barium superoxide and aluminum, and the oxygen from the iron oxide combining with the aluminum, producing a mass of superheated steel at about 5000 deg. F. After the reaction, which takes place from 30 sec. to a minute, the molten metal is drawn from the crucible on the surfaces to be joined. Its extreme heat fuses the metal and a perfect joint is the result.

The directions for preparing, preheating and welding the joint are furnished by the Goldschmidt Thermit Co. W. P.

Amount of CO_2

IN ANSWER to questions under the above heading, on page 586 of the July 1 issue, I submit the following:

1. In burning West Virginia natural gas having a heat content of, say, 900 B.t.u. per cubic foot, how many cubic feet are required to develop one horsepower?

Considering 34½ lb. of water evaporated from and at 212 F., or 33,350 B.t.u., as a boiler horsepower, it would require 33,350 divided by 900, or 37 cu. ft., of gas to develop 1 hp. Seven and one-half cubic feet of Pittsburgh natural gas (about 1180 B.t.u. per cubic foot), is equal in calorific value to 1 lb. good coal.

2. When burning such a gas under a boiler, what per cent of CO_2 will give the best efficiency? The same as coal?

Anthracite coal, being nearly pure carbon, should give close to 21 per cent CO_2; bituminous coal would show less, depending on per cent of hydrocarbons; while natural gas containing, say, 92 per cent marsh gas, would show about 14 per cent CO_2. However, coal is in almost every boiler, burned with excess air, 75 per cent being considered good practice, which would reduce the percentage of CO_2 to 14. Natural gas may be burned with but little excess air, so that under certain conditions they might show the same per cent CO_2.

3. What percentages of CO_2 are required for efficient boiler operation when firing with oil, gas, hard coal, wood, lignite, etc.?

This would depend on per cent of carbon in the fuels.

4. For making CO_2 determinations, in the case of a horizontal water-tube boiler, should the samples be taken from the first, second or third pass?

In general, samples should be taken from the third pass. When Argand or blowing system of feeding gas is used, tests of first and second passes should be taken occasionally, as carbon will burn to CO, the CO to CO_2 under certain conditions, which means loss in B.t.u.'s. H. C.

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Meeting Increased Demands

In examining the various occupations of the present day, we find the introduction of labor saving machinery, and the so-called division of labor and their resulting tendency toward specialization, narrowing the activities and accomplishments of men. Where formerly one man would carry on to completion the work of producing, let us say, a pair of shoes, today, due to modern manufacturing methods, each shoe passes through the hands of a dozen or more workers, who have been trained to do but a small portion of the whole. The result of this great change, which we find in not only the shoe industry but in practically every line of manufacture, is increased production and lower costs. The workman, however, suffers by this state of affairs insofar that he becomes familiar with but a single process, with the consequence that should he be thrown out of employment, it would be exceedingly difficult, if not almost wholly impossible, for him to obtain another position along the line of work in which he has been trained.

Luckily, however, this industrial revolution has had a different effect upon the stationary engineer. In fact, instead of confining his efforts and narrowing his field of activity, the introduction of some of the very elements, namely labor saving machines, which have been so instrumental in bringing about this condition, have placed upon the engineer wider responsibilities, broader activities and necessity for greater knowledge.

In the earliest days of the profession, the power plant consisted of but little more than a coal pile, a fire-tube boiler, a pump or an injector and a slide-valve engine. When not throwing coal into the furnace or oiling the engine, the engineer would be busying himself about the shop, oiling shafting, repairing belts or doing other odd jobs which may have required his attention. Gradually, however, due to the rapid developments in the mechanical and electrical arts and sciences, we find the introduction of the steam heating system, mechanically and electrically operated elevators, sprinkler systems, refrigerating systems, the electric generator and motor and the electric light. Each of these as introduced was put in charge of the engineer, with the result that his field of occupation was broadened and his knowledge and ability increased.

This progress in the field of stationary engineering has not been halted, for today the man in charge of the mechanical and electrical equipment of the modern office building, factory or mill is confronted with the many problems incidental to the care and operation of the electric and gas-driven automobile, high-speed elevator equipment, water purification and air purifying, cooling and humidifying systems. These, together with the equipment used in modern power plants, such as the mechanical stoker, the superheater and the steam turbine, have been instrumental in bringing about beneficial results by eliminating the unfit and uplifting those who have the integrity, perseverance and ambition to improve and fit themselves to meet these new conditions. Modern industrial activities are broadening and elevating the profession of stationary engineering so that today, the man in charge is truly an engineer, a plant manager, and not a mere engine runner.

Editorial Comments

In many of the metal refining industries, electrochemical processes are used which require heavy direct currents at comparatively low voltage. The power plant to supply this current must have certain individual characteristics, but that of the U. S. Metals Refining Co., described in the leading article, is typical for this industry. We wish to call particular attention to the method employed in this plant for proportioning the amount of fuel and air used in the boiler furnaces. While this method cannot give laboratory exactness, with intelligence in handling fires and a study of flue gas analysis, it should prove a thoroughly practical means for maintaining high furnace efficiency. There are other features about this plant that might well be adopted in many of our isolated plants with beneficial results.

Control is the watchword for success. Without it men and machinery run riot to destruction. With it the most difficult tasks can be successfully performed. In a series of articles by Mr. Wells, the first of which appears in this issue under the heading, Engine Governors, our readers will be given the operating principles and descriptions of the various types of governors for the control of engine speed. This is a live and important subject which should not be overlooked because it does not startle you with its newness.

In the article on Oil Fuel, we give the second of the series. This deals with the methods and means for handling fuel oils in plants, and their simplicity compared to that used in coal burning plants shows a marked advantage for oil in this regard.

If, in the operation of your plant, you are not continuously analyzing the losses, bringing them down to the chief offending machine or apparatus, you are failing to do your duty as the engineer. In many plants this analysis of losses is made upon the machine itself and it is to aid in this more detailed study that we publish the article on Transformer Efficiency and Regulation by Mr. McConahey. A close study of this article should aid you in selecting transformers for particular purposes.

As pointed out by Mr Fox, current transformers are dangerous if not properly handled, the secondary circuit cannot be handled like an ordinary circuit and lives have been lost due to ignorance of this fact. The warning given in the article entitled Current Transformer Precaution, should invariably be heeded.

That there are still things to be learned about boiler heating surfaces is evident from the investigations described in the article on Foreign Development in the Power Plant Field. Such simple means for increasing heat absorption are easily applied and the results reported warrants considerable study along this line.

Measurement of feed water has become the generally accepted good practice in power plants; for this, the V-notch weir meter is commonly used, but its accuracy is questioned by some, not because of the weir but on account of the mechanism for recording the head. In the article entitled, Measuring Water with a Weir Meter, a mechanism is described which is based on the buoyancy principle, its accuracy depends principally on shop construction and float difficulties are elinninated.

Ice, being a perishable product, is difficult to deliver long distances without excessive loss. To make distilled water ice requires a steam plant which is objectionable in many localities. In recent years, however, the art of making raw water ice has advanced and in some places small motor driven raw water ice plants well distributed are taking the place of one centrally located plant of the former type. In this issue Mr. Solomon starts a series of 2 articles on the handling of machinery in raw water ice plants which will prove of value to engineers interested in the new arrangement mentioned above.

An interesting question is raised by C. E. Anderson in his article on Galvanized Pipe Gives Trouble in Ice Plant. There appears to be no doubt that the precipitate was due to the galvanizing, but is the ammonia weakened?

Mechanical forces run amuck are as destructive as implements of war. The accident related under the title Flywheel Bursts is the same old story—the governor failed, there was no engine stop. We literally clothe our boilers with safety devices, and Lord knows they need it, but why not be consistent and at least put suspenders on the engine?

Friction is one of the big losses in any plant; the principal agent for reducing these losses is lubricating oil, but there are oils—and oils. An engineer should not be guided alone by statements of agents but should perform a few tests of his own and learn to interpret the results properly. The article on Lubricating Oils in this issue makes valuable suggestions along this line.

On the pages devoted to letters in this issue is a host of practical suggestions for increasing economy and reducing annoyances. Do you have a store room? Is there oil in your feed water? Does your condenser have 2 pumps? Do you have rods to pack? Do your thermometers break? Just go down the list with the thought of improving your own plant and we know you will get at least one new practical idea for adoption in your plant.

Kinks are sometimes workable, sometimes not; we give you the kink for what it is worth—it may suggest some better plan for your case. There are some good ones in this issue.

Most likely some problem came up in your plant recently which was difficult to solve. Others have run against snags if you haven't and you will find the questions and answers to some that have been passed on to us. What we publish in this issue are thoroughly practical and may come up to you at any time; read them and be prepared.

Changes in design of power plant machinery and new machinery to meet changes in practice are constantly coming to the engineer for consideration, and in this issue are published a number of articles in the Power Apparatus department written to aid you in keeping abreast of the times in this direction.

New England Engineers

CONVENTION AT FALL RIVER, MASS., JULY 12 TO 15.

PRELIMINARY arrangements had been in the hands of competent committees of both the stationary and commercial engineers and the effective character of their work was evident when the exercises and exhibition opened on Wednesday evening at the State Armory. The securing of the armory building with its wide area of unobstructed floor space and its convenient location was in itself an important factor in the convention's success, and is to be credited largely to the influence of the Fall River Board of Trade, which, from the first, took an active interest and co-operated cordially with the local committee in making the convention a success.

On the opening night the exercises were conducted by the Commercial Engineers and were presided over by Major W. H. Myrick, president of that organization. They consisted of appropriate speeches by Mayor Jas. H. Kay, H. F. Bracon, vice-president of the chamber of Commerce; J. R. Graham, chairman of the convention committee; A. C. Ashton, of the Ashton Valve Co.; and F. E. Eggleston, secretary of the Commercial Engineers. Throughout the evening, was given an enjoyable program of orchestral selections.

The formal opening exercises of the convention took place on Thursday morning at Anawan Hall, Mayor Kay making a speech of welcome to the delegates, which was responded to by President Riley Daniels. Interesting addresses were made by National President Walter H. Damon, of Springfield; William K. Campbell, past president of the Commercial Engineers; J. T. Maloney, past president of the New England Association of Engineers; Past National President P. H. Hogan, J. D. Taylor of the Life and Accident Department, and T. E. Lahey of the Chamber of Commerce. J. D. Graham, chairman of the convention committee, presided.

The business session of the delegates took place on Friday afternoon and the roll call showed the attendance to be the largest in the history of the Association. Reports by Retiring President Riley Daniels, and the various committees gave gratifying assurance of satisfactory conditions and bright prospects for the organization. A climax of enthusiasm was reached when it was announced by the secretary that the Connecticut organization, including Bristol, Meriden, New Haven, Hartford and Bridgeport had become affiliated with the New England Association, bringing an addition of 430 members and making the New England organization practically complete.

The following officers were elected and installed to serve for the ensuing year: President, John Quinn, of Holyoke; vice-president, Joseph Eccleston, New Bedford; past president, Riley Daniels, Pawtucket, R. I.; secretary, James H. Henderson, Boston; treasurer, Walter H. Damon, Springfield; conductor, Andrew Waits, Portland, Me.; doorkeeper, D. A. Dolbear, Norwich, Conn.

After a spirited contest with Bridgeport, Conn., it was voted unanimously to hold the convention of 1917 at Portland, Maine. The use of the fine new City Hall very centrally located on the main street has been promised for the occasion.

In the evening the Commercial Engineers took charge of the proceedings and gave delegates a varied and enjoyable entertainment at Anawan Hall.

At a meeting held in the rooms of the Board of Trade a large amount of important business was promptly and competently transacted by the Commercial Engineers and the following officers of the Association were elected:

President—F. S. Eggleston, Jr., of Boston.

Vice-President—J. A. Morehouse, Boston.

Treasurer—J. W. Myrick, Boston.

Members of Board of Directors (three years)—C. B. Burleigh, H. M. Colby and P. H. Hogan, all of Boston.

By unanimous vote Mayor James H. Kay was elected an honorary member of the Association. It was announced that the Power Show of the Commercial Engineers was the largest yet given by the organization.

Saturday was devoted to an enjoyable outing for which ample provision had been made. The program included an automobile ride to various points of interest about the city, a ball game between the Stationary and Commercial Engineers, and a genuine Rhode Island clam-bake.

EXHIBITORS

A LARGE share of the interest and success of the convention was due to the elaborate display of apparatus made by the manufacturers of power-plant goods which were shown to the best advantage by their competent representatives. The following firms participated:

Albany Lubricating Co., New York City; American Abrasive Metals Co., New York City; American La France Fire Engine Co., New York City; American Oil Co., Providence, R. I.; American Plumbing & Heating Co., Fall River, Mass.; American Pulley Co., Philadelphia, Pa.; American Steam Gauge & Valve Mfg. Co., Boston; Ashton Valve Co., Boston; Belmont Packing & Rubber Co., Philadelphia; J. Henry Blanchard, So. Norwalk, Conn.; Blanchard & Butler; Jefferson Borden & Son; Babbitt Steam Specialty Co., New Bedford, Mass.; Bowers Rubber Works, San Francisco; Bradford Durfee Textile School, Fall River; Budd Grate & Foundry Co., Philadelphia; A. M. Byers Co., Pittsburgh; W. D. Cashin; Chace Electric Co., Fall River; Chapman Valve Mfg. Co., Indian Orchard, Mass.; A. W. Chesterton Co., Boston; Chicago Pneumatic Tool Co., Chicago; Climax Smoke Preventer Co., Boston; Coppus Engineering & Equipment Co., Worcester, Mass.; L. A. Couch; Crandall Packing Co., Palmyra, N. Y.; Dearborn Chemical Co., Chicago; Delaware Railway Specialty Co.; Eagle Oil & Supply Co., Boston; Economy Lubricating Co., Boston; Elliott Co., Pittsburgh; Evans Mill Supply Co.; Fall River Boiler Works, Fall River; Fall River Electric Light Co., Fall River; Fall River Gas Works Co., Fall River; Fall River Steam & Gas Pipe Co., Fall River; France Packing Co., Philadelphia; Gardner Grate Co., Boston, Mass.; Garlock Packing Co., Palmyra, N. Y.; Hart Packing Co., Boston; Hart-Edison Packing Co.; Home Rubber Co., Trenton; Huber Hand Stoker Co., Inc., New York City.; W. J. Hyland Mfg. Co.; Jefferson Union Co., Lexington, Mass.; Jenkins Bros., New York City; H. W. Johns-Manville Co., New York City; John F. Johnston Co.; Keystone Lubricating Co., Philadelphia; Kilburn Lincoln Machine Co.; Lead Lined Iron

Pipe Co., Wakefield, Mass.; Locke Regulator Co., Salem, Mass.; Lunkenheimer Co., Cincinnati, O.; Manning, Maxwell & Moore, Inc., New York City; Mason Regulator Co., Boston; McClave-Brooks Co., Scranton; McLeod & Henry Co., Troy, N. Y.; W. B. McVicker Co., New York City; P. A. Meehan; Nathan Miller Sons; National Engineer, Chicago; Nelson Blower & Furnace Co., Boston; New York Belting & Packing Co., New York City; New York Revolving Portable Elevator Co.; Nightingale & Childs Co., Boston; Patten Bros., Inc.; Patterson Lubricating Co., Boston; Peerless Rubber Mfg. Co., New York City; Perfection Grate Co., Springfield, Mass.; Philadelphia Grease Mfg. Co., Philadelphia; Power, New York City; Power Supply Co.; Practical Engineer, Chicago; Pratt & Cady Co., Inc., Hartford, Conn.; Quaker City Rubber Co., Philadelphia; Rockwood Sprinkler Co., Worcester, Mass.; Roto Co., Hartford, Conn.; Schmelzer & Arthur Mfg. Co., Inc., Boston; Schumaker-Santry Co.; Southern Engineer, Atlanta, Ga.; Spencer Turbine Cleaner Co., Hartford; Thermal Appliance Co., Inc., New York City; John Whalen Co., Boston; Wm. R. Winn, New York City.

Blue Grass Engineers

CONVENTION AT LOUISVILLE, KY., JUNE 27 TO 29

AT 10:30 o'clock, the 14th Annual Convention of Kentucky Engineers was called to order at Hotel Henry Watterson, and after prayer by Rev. R. B. Grider, Chairman Wyly of the Local Entertainment Committee introduced Mayor J. H. Buschmeyer, who welcomed the assembly, commented on the advantages of Louisville as a manufacturing center, and wished the engineers a good time while there. State President Moore spoke of the advantage of applying technical methods to power production in reducing cost of power and the prices of factory products. J. J. Davis, of the Louisville Board of Trade, spoke of the growth of the city, and the secure foundation for its prosperity, and Arthur Kays, of Louisville Manufacturers' Exhibition, invited the delegates to visit that display of Louisville products and to partake of its hospitality. J. F. Hurst, president of the Louisville Local Association, urged the members to invite other engineers to associate meetings, so that they might see the good accomplished and have the chance to become members.

In the absence of President Fiske of the Exhibitors' Association, Past-President Chas. Cullen opened the exhibition and invited delegates, visitors and the public to make full inspection of the 40 or more interesting exhibits on the 10th floor of the hotel. The meeting was then turned over to President Moore, who appointed the regular committees, and the report of the committee on a combined convention of 3 states, recommending that the separate state conventions be continued, was adopted. Tuesday evening was devoted to attendance in the Exhibit Hall, inspecting the exhibits and enjoying the entertainment provided by the exhibitors.

On Wednesday morning, papers were read by Geo. A. Padee on the Future of the Isolated Plant, by John F. Hurst on the Benefits of Membership in the N. A. S. E., and by J. J. Nelis of the Babcock & Wilcox Co., on the High Pressure Boiler. The official photograph was taken following the morning session, and a visit was then paid to the manufacturers' exhibit as guests of the Louisville Convention and Publicity League, also an inspection tour was made of the canal and locks at Portland. Wednesday night was marked by a river trip on the Queen City, which was greatly enjoyed by all.

At the Thursday morning meeting, A. W. Lee read an interesting paper on Lightning Protection Devices, and C. C. Sharp one on Sampling Coal Deliveries. After discussing the place for the 1917 convention, this was left to be decided by the state president and the Exhibitors' Association before January 1, 1917. The convention appropriated $50 for expenses of the state president in organizing new associations, and memorial services were held for deceased members.

Election of officers resulted as follows: President, John F. Hurst, Louisville; vice-president, J. R. Morris, Hopkinsville; secretary, Geo. J. Jake, Hopkinsville; treasurer, W. H. Elliott, Louisville; conductor, T. A. Cassin, Central City; doorkeeper, C. Carrol, Louisville. For national state deputy, C. S. Moore, of Lexington, was nominated.

At its meeting, the Exhibitors' Association elected Mr. Henchman as president, and President Hurst of the N. A. S. E. presented Past-President Moore with a silver badge.

The formal convention then adjourned and the engineers were escorted to the Waterside Station of the Louisville Gas & Electric Co. by President Hurst, who showed them one of the most up-to-date plants in the South, and also the great intake tunnel which is being built to the plant from the Ohio river.

Thursday evening, the exhibitors and local entertainment committee gave an Irish luncheon and smoker in the Rathskeller of the hotel, where C. Wyly of Jenkins Bros. acted as toastmaster.

Exhibitors present were as follows: The V. D. Anderson Co., Cleveland, O.; The Ahrens & Ott Mfg. Co., Louisville; The Babcock & Wilcox Co., New York City; Bowers Rubber Works, San Francisco, Cal.; Crandall Packing Co., Palmyra, N. Y.; Andrew Cowan & Co., Louisville; Childers Electric Co., Louisville; Dearborn Chemical Co., Chicago; M. H. Detrick & Co., Chicago; Edward Valve & Mfg. Co., Chicago; Garlock Packing Co., Palmyra, N. Y.; Gunther & Hughey, Louisville; Hawk-Eye Compound Co., Chicago; Henry Heick Hdw. Co., Louisville; Home Rubber Co., Trenton, N. J.; H. W. Johns-Manville Co., New York City; Jenkins Bros., New York City; Jenkins Graphite Lubricating Co., Louisville; Keystone Lubricating Co., Philadelphia, Pa.; Lunkenheimer Co., Cincinnati, O.; Louisville Gas & Electric Co., Louisville; Laib Co., Louisville; Louisville Sanitary Wipers Co., Louisville; Merchants Ice & Cold Storage Co., Louisville; W. R. Martin Co., Louisville; E. D. Morton & Co., Louisville; National Engineer, Chicago; National Steam Pump Co., Upper Sandusky, O.; National Foundry & Machine Co., Louisville; The Wm. Powell Co., Cincinnati, O.; Peerless Rubber Mfg. Co., New York City; Power, New York City; Practical Engineer, Chicago; G. L. Simonds & Co., Chicago; The Southern Engineer, Atlanta, Ga.; Schaeffer & Budenberg Mfg. Co., Brooklyn, N. Y.; Standard Oil Co., Indiana; Henry Vogt Machine Co., Louisville; P. A. Vogel & Sons, Louisville; Western Valve Co., Chicago.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Beyer Barometric Condenser

COMPLETE steam condensing plants, including the Beyer barometric condenser, Imperial duplex and Ingersoll-Rogler straight line, reciprocating, dry vacuum pump and, where required, Cameron simplex and centrifugal pumps are now being marketed by the Ingersoll-Rand Co.

The Beyer barometric condenser is of the counter-current type, in which air and cooling water flow in opposite directions. The steam inlet is at the bottom of the condensing vessel, the water inlet above and the

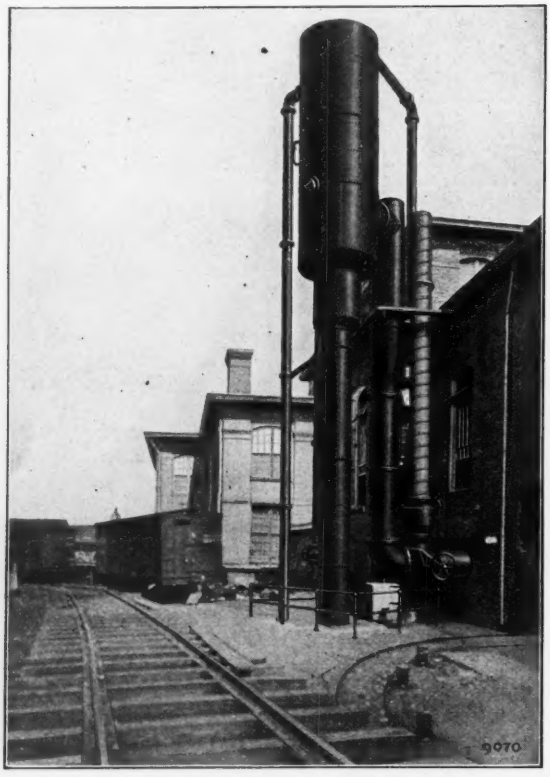


FIG. 1. BEYER BAROMETRIC CONDENSER INSTALLED AT THE NEWBERRY COTTON MILLS, NEWBERRY, S. C.

air removal opening at the top. The sheets of cooling water overflowing the pool at the inlet point meet the entering steam. The two are brought into intimate contact by conical baffle plates, assisting the water to absorb to its full capacity the latent heat of the steam. The noncondensible air liberated in the condensing action, rises through the falling water to the removal point at the top, being cooled to practically the temperature of the incoming water. It is also to be noted that ample opportunity is given for the removal of the air content of the water before it mixes with the steam. This the manufacturer points out not only facilitates the mixing process, but permits the removal of air and vapor at a

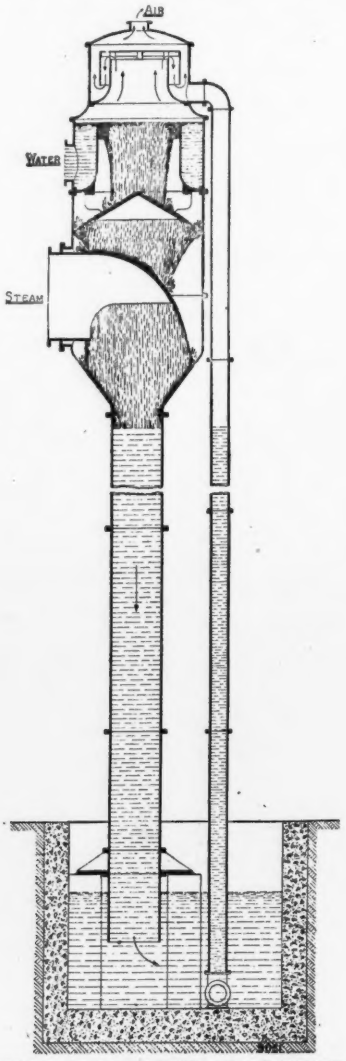


FIG. 2. SECTIONAL VIEW OF BEYER BAROMETRIC CONDENSER

comparatively low temperature, a distinct advantage, as the reduced volume saves in vacuum pumpage horsepower.

To secure low velocity, the steam inlet is of large diameter and is hooded in such a way as to discharge the steam into the center of the condensing vessel. The air removal opening is also of ample area and is protected by a self draining baffle and trap. This, it is

said, positively prevents water being carried over into the vacuum pump. The hot waste water is discharged through the self draining tail pipe. This pipe straddles the hot well and rigidly supports the condenser.

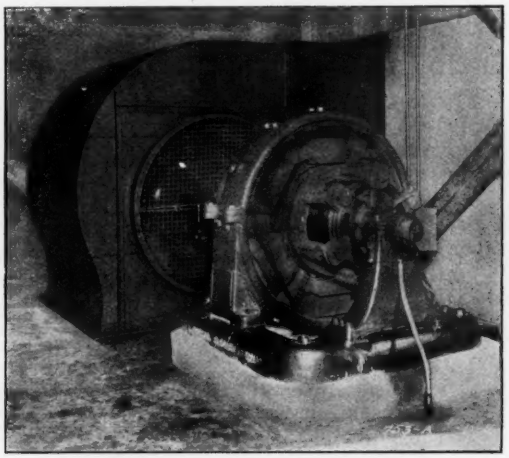
Imperial and Ingersoll-Rogler vacuum pumps are of the manufacturers' standard type. They are high speed reciprocating machines, wholly enclosed, automatically lubricated and are said to effect a floor space saving approximating 50 per cent over the more common slower speed vacuum pumps.

When a water pump is required to elevate cooling water to the condenser head Cameron pumps are provided. These may be either reciprocating or centrifugal as desired. The Ingersoll-Rand Co., however, emphasizes the fact that, where the level of the cold well is of sufficient height above the hot well, the condenser will lift its own cooling water, dispensing entirely with a water pump.

In presenting this equipment, the manufacturer brings out the point that the vacuum and water pumps, being independently operated, can be regulated to suit varying water temperatures and conditions, and that this plant, in addition to its efficiency in general service, is admirably adapted for duty as a central condensing unit serving a number of prime movers.

Blowers in Connors Creek Plant

IN the Connors Creek plant of the Detroit Edison Co., Detroit, the original boiler installation consisted of 6 2365-hp. Stirling Edison type boilers, each boiler being equipped with a 26-retort Taylor stoker, and each boiler served by one fan supplying 74,000 cu. ft. of free air per minute at a static pressure in the air chamber under the stokers of 6½-in. water gage. In addition,



VIEW OF BLOWER AS INSTALLED IN CONNORS CREEK PLANT

each pair of boilers has a spare fan of the same capacity with cross-over connections and damper, so that the spare fan may supply either of the 2 boilers.

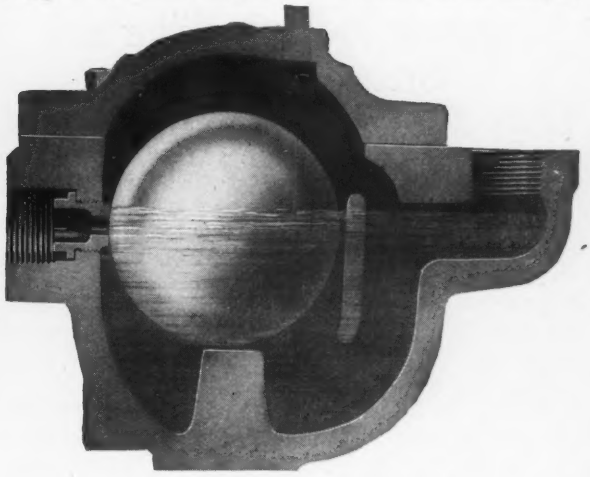
These fans are driven by direct-connected variable speed G. E. Co. motors through flexible couplings, and the capacity of each stoker and fan unit is designed to be such as to operate the boilers at 255 per cent of rating without economizers, using West Virginia bituminous coal with a heating value of 14,000 B.t.u. The fans are Buffalo Conoidals of the heavy pressure type specially designed by the Buffalo Forge Co. for stoker work with independent wedge adjusting spherical type bearings made so as to be oil and dust tight. The maximum speed at which these fans operate is 750 r.p.m., and tests made since the installation show that at this speed the boilers can be run at from 275 to 300 per cent of rating. The extension to the Connors Creek power house, which is under construction at present, will require 3 more boilers of the same size, and on account of the satisfactory operation of the blowers already installed, the order has been placed with the Buffalo Forge Co. for the additional equipment.

Besides the Connors Creek plant, heavy pressure stoker fans made by the Buffalo Forge Co. are now in operation in the Detroit Edison Co.'s Delray and Park Place plants, and including equipment now on order, there are a total of 25 blowers for stoker work.

For cooling the generator rooms at the Connors Creek station, carrier generator humidifiers have been installed on the roof, cooling and moistening the air supplied by Niagara Conoidal fans, and a similar installation for the new extension is being furnished by the Carrier Air Conditioning Co. of America, which is under the same ownership and management as the Buffalo Forge Co.

Ball Operated Steam Trap

A NON-ATTACHED rolling ball is subjected to a pressure equal at all points except that area resting against the discharge orifice. When condensation enters the trap through the inlet, the ball rolls up, exposing the discharge opening, and permits a discharge of water and air. This is the operating principle of the J-M steam trap. While the condensation acts as a lifting force which is responsible for the uncovering of the outlet into which the water and air escapes,



JOHNS-MANVILLE STEAM TRAP

the steam pressure simultaneously forces the ball to seat itself against the upper part of the opening with sufficient pressure to prevent any discharge of steam.

A feature of advantage claimed for this trap is that it cannot air-bind, as the air, being heavier than steam and lighter than water, forms a film on the surface of the water and is carried out with it. Cover, body, and ball are the only parts of this simple trap, which is a product of the H. W. Johns-Manville Co.

A New Transformer Oil

LECTROSEAL, a new grade of insulating transformer oil recently introduced by the Westinghouse Electric & Manufacturing Co., has its chief application as an insulating and cooling medium for use with all classes of oil-insulated distributing and power transformers. It is also used with such apparatus as induction-type feeder regulators and electrolytic lightning arresters.

Lectroseal is a pure mineral oil, obtained by the fractional distillation of petroleum, and is free from moisture, acid, alkali and sulphur compounds. As an insulating medium, it has a high dielectric strength, the average breakdown test being said to be 40,000 v. on a 0.15 in. gap between spheres ½ in. in diameter. As a cooling medium, it is claimed that this is particularly well adapted, the viscosity being very low. Consequently, the oil will circulate rapidly and transfer the heat quickly from the transformer or other apparatus to the walls of the tank.

If water should accidentally enter a transformer tank, it should sink to the bottom of the tank as quickly as possible, as a small percentage of water thoroughly mixed with the oil reduces its dielectric strength rapidly. Various grades of oil differ greatly as to their ability to separate from water with which they have been mechanically mixed, but Lectroseal, it is claimed, possesses this quality in a marked degree.

Other characteristics claimed for this oil, such as freedom from deposit, satisfactory flash and fire point, low rate of evaporation and light color, would indicate that it is practically ideal for the purpose for which it is intended.

Lagonda Multiple Filter and Grease Extractor

EFFECTIVE extraction of oil and greases from water is realized only by means of successive filtration through a series of filters, each of ample capacity to permit the comparatively slow percolation of the water through the grease absorbing and extracting medium. To secure such successive or multiple filtration in a filter occupying comparatively small space, the Lagonda Manufacturing Company, of Springfield, Ohio, has developed a filter and grease extractor in which the filtering medium consists of a long strip of Terry linen wound in several layers on a large spool, the successive layers being properly separated by a flexible wire mat. This construction is shown in the accompanying illustration. The water entering the filter chamber at the top, flows down through the perforated core of the spool and filters out in all directions through the successive layers of Terry linen into the spool chamber and the outlet. The large diameter and length of the spool provides large, effective filtering area and maximum capacity of each layer with minimum resistance to the flow.

The Lagonda Filter is a double-unit machine consisting of 2 complete filters, each of which will furnish the rated capacity. The 2 filters are connected by double control valves into a self-contained unit and the normal operating condition is to have one chamber in service at a time, leaving the other ready to be cut in for use when it becomes necessary to change the spool. In time of excessive demand, both filters can be cut in, in parallel to double the capacity of the machine.

To facilitate cleaning, the covers of the filtering chambers are provided with hinged slot bolts and each chamber with a double arm lifting davit mounted on ball

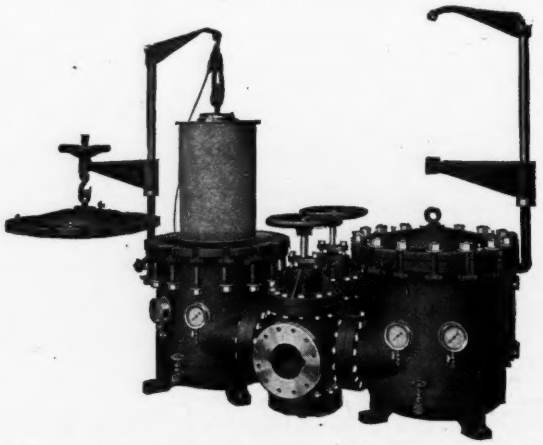


FIG. 1. LAGONDA FILTER AND GREASE EXTRACTOR, SHOWING ONE CHAMBER OPENED FOR CLEANING WITH THE FILTER SPOOL SUSPENDED FOR DRAINING BEFORE REMOVAL

bearings. When the cover bolts are loosened, the cover is easily raised and swung aside by the lower davit arm. The filtering spool is then lifted out by the self-locking block tackle suspended from the upper davit, as shown in Fig. 1. In this position the spool is allowed to drain for some time to prevent mussiness about the machines. As each machine is furnished with a complete extra spool, this can be inserted immediately and the fouled spool placed aside for cleaning.

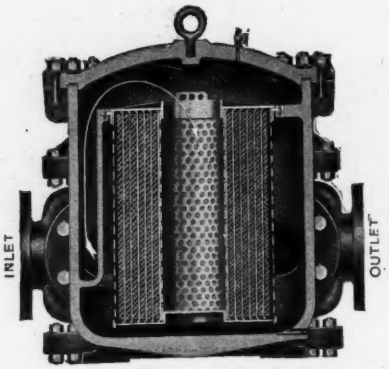
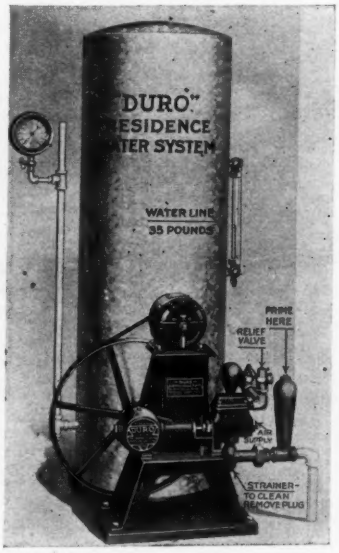


FIG. 2. SECTIONAL VIEW OF LAGONDA FILTER AND GREASE EXTRACTOR, SHOWING PERFORATED SPOOL CORE AND LAYERS OF TERRY LINEN

This new filter combines in a single, comparatively small unit, all the characteristics for oil extraction and filtration of the larger space-taking filter beds. Placed between boilers and pumps, it offers a simple, effective and economical means of filtering the boiler feed.

Duro Residence Water System

THE Duro residence water system, made by The Burnett-Larsh Mfg. Co., Dayton, Ohio, consists of a single or duplex, double-acting pump, with motor, and a tank. It is used for automatically pumping soft or rain water from cistern to bathroom, kitchen, and laundry, under pressure, and was developed to fill the demand for a reliable, small outfit for residence service to take the place of water motor pumps and water lifts. The price of the outfit is practically the same as a water motor pump or water lift and it is said can be used to advantage at extremely low cost in even the smallest homes.



ELECTRICALLY DRIVEN PUMP FOR HANDLING SOFT WATER IN RESIDENCES

This outfit is practically noiseless in operation. The pump is belt driven by a Westinghouse motor—direct current, or single-phase alternating current with heavy duty overload starting, designed especially for pump service. There are 4 sizes of pumps used with capacities of 100, 160, 200 and 360 gal. per hr., requiring 1/12, 1/8, 1/6 and 1/4 hp. motors, respectively. The tanks furnished are either black or galvanized and have capacities from 40 gal. up. The vertical suction lift of the pump is 22 ft.

The system is entirely automatic, the pump starting when the pressure in the tank falls to 22 lb. and stopping at a maximum pressure of 35 lb., by means of an automatic electric switch. In order to provide the necessary air pressure, an air pumping device is furnished. The pump is also equipped with a suction strainer to prevent pipe dope, scale, dirt, and foreign matter from getting into the pump and fouling the valves.

THE SECRETARY of a commercial organization in Siberia has written an American consular officer requesting a list of dealers in iron pipes and steel products. Pipes ranging from ½ in. to 3 in. in size are particularly in demand.—Commerce Report.

Uniflow Engines for Youngstown Sheet & Tube Co.

IN this country, the first Uniflow engines for rolling mill work are those now under construction by the Nordberg Manufacturing Co., Milwaukee, Wis., for the Youngstown Sheet & Tube Co., Youngstown, Ohio, the larger to drive a 12-in. rod mill, the smaller a 9-in. rod mill. The cylinder is a plain cylindrical casting, all valve chambers and steam passages being contained in the heads, bolted to the ends of the cylinder. This prevents distortion and strains due to expansion and contraction with the use of high pressures and superheats.

Steam valves are of the poppet type, the valve cages being separate castings which are ground into the heads with a steam tight joint. The valves are of the double seat, balanced poppet type and no packing is required for the valve stems, which are accurately ground and polished and work in ground and lapped bushings. The valves are operated from lay shaft by a releasing valve gear with spring dashpots, the cutoff being under control of the governor through the wide range of loads. The steam enters the cylinder at the bottom, sweeping up over the heads and jacketing them before entering the valve at the top.

Exhaust is through the ports in the center of the cylinder uncovered by the piston near the end of its stroke. Relief valves of the poppet type with cataract dampening device are located near the bottom of the heads. In case of loss of vacuum and over-compression these valves automatically open and connect the clearance space of the cylinder with the steam space in the head and the communicating steam piping. The steam conditions will be approximately 170 lb. pressure, 75 deg. F. (24 deg. C.) superheat, and 20 in. vacuum, steam being condensed by barometric jet condensers.

The larger engine is 44 by 50 in., 110 r.p.m. and will have a capacity from 700 hp. to between 3000 and 4000 hp. The weight, including 110,000-lb., 10-ft. flywheel, will be 480,000 lb. The second engine is a 37 by 48 in. at 110 r.p.m. and its weight, including a 90,000-lb. flywheel, will be 360,000 lb.

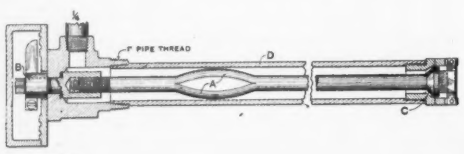
THOSE EMPLOYES of the Joseph Dixon Crucible Co. who had joined the National Guard prior to its being called by the President and subsequently sworn into the Federal Service in June, 1916, will receive full pay while away doing military duty. These men will have their places kept open for them. This provision holds good until future developments make it necessary to change it or modify it.

RECENTLY COMPILED STATISTICS show that the hydraulic power available in Spain is something over 5,000,000 hp. There are at present 110 large plants, developing 281,500 hp., and a number of small plants, the total estimated development being 300,000 hp., which will be increased to 500,000 during 1916. Work on the Ebro river, which is under way, will when completed bring this up to 700,000.

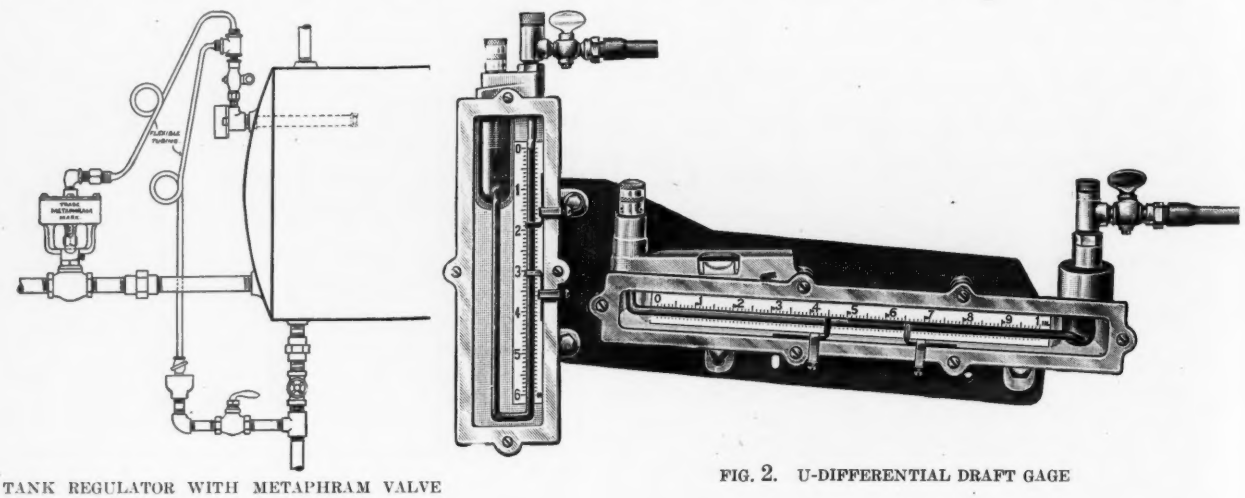
Graduate Action Tank Regulator

OPERATING from the direct water pressure of the tank, and with graduated action, the Metaphram hydraulic tank regulator is offered as a simple and compact temperature regulator.

Stem D, shown in the cross section view, being provided with a 1-in. pipe thread, is inserted into the tank and subjected to the water under pressure. When the temperature of the water rises, A, a highly sensitive element, readily expands, and the valve, C, attached to the end of the element, is thrust from its seat, allowing the water under pressure to rush through the stem of the regulator and thence to the diaphragm motor or valve, whichever the case may be, and shuts off the heat source. When the temperature of the water falls, the element, A, contracts quickly and pulls the valve, C, to its seat, preventing further flow, and consequently the motor or valve will expel its pressure through the waste and thus open the heat source. Adjusting indicator B is provided with a wide range on the face of the regulator, and a cover locked on by countersunk screws to prevent tampering.



CROSS SECTION OF NATIONAL REGULATOR



TANK REGULATOR WITH METAPHRAM VALVE FOR CONTROL OF STEAM HEATED TANK

This regulator, which is 15 in. long, is shown in Fig. 2, connected to a steam heated tank. It is manufactured by the National Regulator Co., of Chicago.

New Ellison Draft Gages

TO secure and maintain highest furnace efficiency, particularly where forced draft is employed, a knowledge of draft conditions through the boiler setting is imperative. It was with the object of giving to the firemen as complete and accurate information as possible along this line that Lewis M. Ellison has designed and constructed the 2 instruments illustrated herewith.

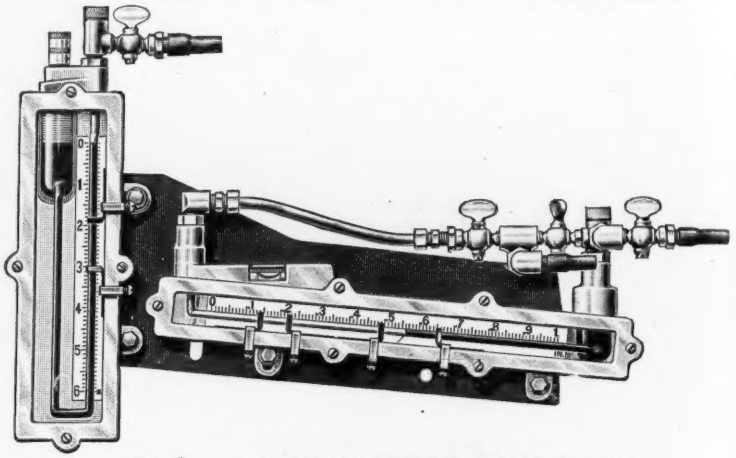


FIG. 1. U-COMBINATION DIFFERENTIAL DRAFT GAGE

In Fig 1 is shown the Ellison U-combination differential draft gage which is particularly adapted for underfeed stokers and forced draft furnaces. It consists of a U gage with dust proof vent cap and connection, mounted with a combination gage on a light and compact cast-iron base. The U gage is so connected as to indicate the air pressure under the furnace in inches of water; being intended for use in boiler rooms where considerable dust collects, the gage is enclosed with a glass cover to aid in maintaining the legibility of the gage and preserving its accuracy.

FIG. 2. U-DIFFERENTIAL DRAFT GAGE

By a system of cross piping, the differential gage is adapted to give the furnace draft, the flue draft or the differential between the flue and furnace independently on a single tube gage. Pointers are arranged on the scale to indicate the limits of good practice, the furnace pointers being the first pair and the differential the second. Ordinarily the gage is operated to give differential readings as these usually have a wider range than the furnace draft; momentary readings, however, are taken of the furnace and flue draft as a check on operation.

Ellison U-differential draft gage, shown in Fig. 2 differs from that described above only in that no cross piping is employed on the inclined gage. The readings given therefore are the air pressure and the furnace or flue draft as piped. It is used in boiler installations where the differential readings between furnace and flue are not wanted.

These instruments are the product of Lewis M. Ellison of Chicago.

Improved Turbo-Blower Designs

THREE designs of turbo-blower are now offered with several improvements by the Power Turbo-Blower Co., of 338 Whitehall Buildings, New York City. The first and most powerful, called the "Power" turbo-blower, has a large rotor cast in on a solid piece of bronze with nickel steel buckets cast to the rotor body and the outer bronze ring at one process. The rotor is machined all over to give balance and fit and is fastened by means

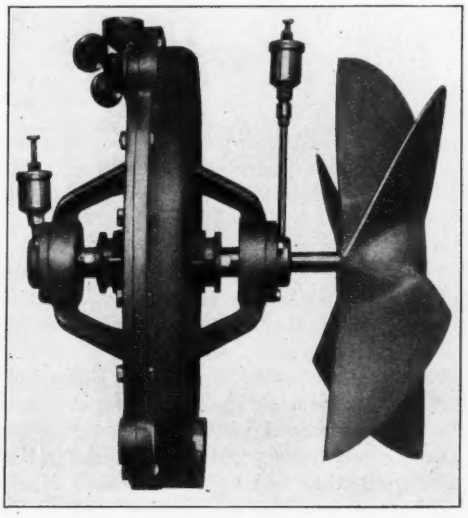


FIG. 1. THE "POWER" TURBO-BLOWER WITHOUT CASING

of countersunk screws to a large flange which is shrunk on the propeller shaft. Support for the shaft is by 2 heavy ball or oil ring bearings carried on brackets from the halves of the casing and completely enclosed against steam and dust by caps which also act as grease reservoirs.

Halves of the casing have carefully machined inner surfaces to reduce friction and give alinement and a steam tight fit, and are bolted together substantially.

Steam is admitted to a small chamber on the upper part of the outer casing half and passes through 3 nozzles controlled by separately operated needle valves so that one or more nozzles may be used to control speed as required. Exhaust is to a chamber at the bottom of the inner casing half from which the steam may pass with the air into the ashpit or be piped away to feed heater or heating system.

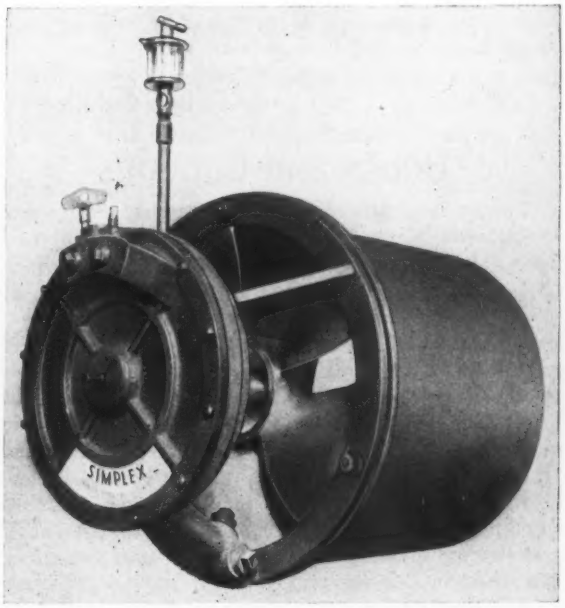


FIG. 2. "SIMPLEX" TURBO-BLOWER COMPLETE

On the inner end of the shaft, the propeller, a strong casting of aluminum alloy is mounted and secured by a key and locknut. It is surrounded by a cast casing which is securely set in the masonry of the boiler wall and to which the turbine casing is bolted with distance

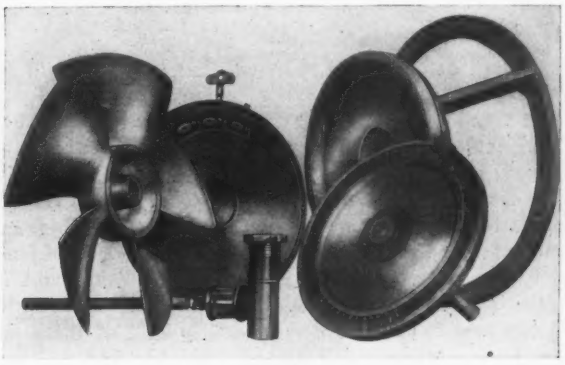


FIG. 3. PARTS OF THE "SIMPLEX" BLOWER BEFORE ASSEMBLING

pieces, so that no extra means of support is required. This blower will furnish draft for boilers up to 600 hp.

Where less capacity will be sufficient, the "Simplex" turbo-blower is satisfactory. In general arrangement, it is the same as the "Power" blower, but has a somewhat smaller and lighter rotor which permits of simpler construction. To reduce construction work, the inner casing half, brackets and spider ring are made a single casting, and one bracket serves also as exhaust pipe.

Also the turbine ring, the rotor and the rotor hub are combined into a single piece, and the main bearing, the thrust bearing and the packing gland are in one.

There is the same balance of rotor and propeller, the same individual nozzle control and small steam chambers, and the same provision for piping away exhaust if desired as in the larger machine. Because of this exhaust provision, these blowers may be used for ventilating fans, the spider ring being bolted direct to the wall or placed in the window frame of the room to be ventilated.

Books and Catalogs

POWER TRANSMISSION BY LEATHER BELTING, by Robert Thurston Kent; 114 pages, 31 illustrations; first edition; New York, 1916. Price, $1.25.

Increased demands placed upon shop machinery due to heavier loads carried and more efficient operation have rendered the problem of belt maintenance one of the most important of the many the superintendent, master mechanic or engineer is called upon to solve. Concurrently with the improved methods of production witnessed within the past 15 yr., belting practice has changed considerably with the result that the man who has aught to do with the purchase or care of belting must apply considerable theoretical knowledge along this particular line and cannot, as heretofore, solely rely upon any rule-of-thumb.

Literature up to the present available on this subject was more or less in fragmentary form and it has been the aim of the author to gather the best of such information on the latest practice and compile it in a form serviceable to the belt user.

While some theoretical matter has been introduced and especially in those sections devoted to design, no more than sufficient to enable the student to obtain a thorough understanding of the principles upon which practice is based, is employed.

Chapters I, II, III and IV are devoted to the subjects of General Considerations Affecting the Transmission of Power by Belting, Taylor's Investigations on Belting, The Horsepower Transmitted by Leather Belting, and Theory of Transmitting Power by Belting, respectively. The last 4 chapters covering belt maintenance, methods of fastening belts, miscellaneous notes on belting and pulleys are of a more practical nature and should not only appeal to the man in charge of belting and its allied equipment, but should prove of great value in his daily work. This may be especially said of those sections bearing upon belt records, cleaning and dressing, methods of fastening and the methods of locating pulleys.

Numerous tables for use in connection with the text are found on the last 20 pages of this volume.

CENTRAL STATION MANAGEMENT, by H. C. Cushing, Jr., and Newton Harrison; 397 pages, cloth binding. New York, 1916. Price, $2.

It is the attention to details in central station management that makes the dividing line between profitable and unprofitable generation, transmission and sale of current. It is the fair and cordial relations between the public service company and the public that establish the permanency of the central station. To emphasize and make clear these two principles is the purpose of the authors in offering this work.

One subject treated which is of country-wide civic interest, and about which there is constant discussion, is the question of rates, and particularly the minimum charge rate. The various factors which must form the basis for establishing rates are outlined in detail, and the services of public utility commissions favorably mentioned. Some conclusions from the discussion on establishing rates are: That a minimum or least charge for current is advisable; that the charge for current should be such as to embrace the features of labor and fuel, clerical and outside hire as definitely associated with the operation of a central station; that the charge for current either according to a flat rate or a variable rate, is entirely a matter of obeying the law first, and following business instincts second, to provide a profit satisfactory to its manager, board and stockholders.

Lighting is divided into its different forms and the fundamental principles of scientific street lighting, house lighting, and the correct methods of illumination, are treated in a complete manner. The closing chapters are devoted to a general discussion of boiler room management, considering the subjects of boiler capacity, efficiency and operation.

Covering a large field in a thorough, comprehensive manner, this book is a valuable addition to central station literature.

YEOMANS DUPLEX electric centrifugal sewage ejectors for automatically raising sewage and drainage in basements below street sewer level, municipal sewerage systems, etc., are described and illustrated in Bulletin No. E-2000, of Yeomans Brothers Co., 231 Institute Pl., Chicago.

Bulletin No. S-1000 from the same company deals with small electrically driven centrifugal pumps for house supply and general service in all classes of buildings.

INSTRUMENTS for recording carbon dioxide in flue gases are described in Bulletin 91 of the Bureau of Mines, Department of the Interior, J. F. Barkley and S. B. Flagg, authors.

In explaining why the Bureau of Mines has issued a report of this character, the authors say: "In the past few years an awakened activity in power-plant economies has resulted in a marked improvement in the equipment for generating and utilizing steam. Much attention has been given to the boiler room in efforts to obtain proper combustion of the coal, because of the importance of the coal item in costs of power production. As evidence of this increasing interest may be cited the record of the development within the past few years of new apparatus for the analysis of flue gases. Many new forms of apparatus have appeared, including those for the determination of carbon dioxide, oxygen, and carbon monoxide, and others for indicating and for recording the content of carbon dioxide only, as carbon dioxide content is usually a good indicator for the control of furnace operation. Tests of several different types of recorders were made under service and laboratory conditions in order to obtain needed information.

The purpose of the Bureau of Mines in publishing the results is to show the factors which may affect the accuracy of a carbon dioxide recorder and the manner in which a recorder should be tested."

Copies of this bulletin may be obtained free of charge by addressing the Director of the Bureau of Mines, Washington, D. C.

AMERICAN SHIPPING now has an opportunity such as England had 50 yr. ago, according to a report on "Government Aid to Merchant Shipping" just made public by the Bureau of Foreign and Domestic Commerce. This opportunity, says the report, comes at a time when American citizens owning foreign-built ships can ply them under the American flag, when interest in foreign trade is widespread, the necessity for foreign markets clearly recognized, and the profitableness of shipping under present conditions is alluring. The report is entitled "Government Aid to Merchant Shipping," Special Agents Series No. 119. It contains in all 255 pages and is sold at the price of 25 cents by the Superintendent of Documents, Washington, D. C.

THE LOGIC OF THE DEAN is the title of an attractive new 20-page booklet just issued by The William B. Pierce Co., Buffalo, N. Y., illustrating and describing their Dean Boiler Tube Cleaner. The booklet is intended primarily for the management of the plant, although it contains a wealth of information of unusual value to the chief engineer or any of his assistants. Besides describing and illustrating the operation of the Dean Cleaner, it discusses the scale problem in detail. A copy may be had by addressing The William B. Pierce Co., 57 North Division Street, Buffalo, N. Y.

INSULUMINUM, Bulletin 118, just issued by the Diamond Power Specialty Co., Detroit, contains a number of photo-micrographs and describes the properties of this new product of the General Electric laboratories, which will withstand a continuous temperature of 1800 deg. F., as compared to 1200 deg. F., for iron and steel. Photographs and records of a series of comparative tests at high temperatures of Insuluminum and iron pipes, made by a number of well-known companies, are included. The bulletin is readable. It deals primarily with the interesting new metal, but the application of the material to the Diamond Mechanical Soot Blower System is described briefly on the concluding page.

FOR THE purpose of studying the web strains in I-beams and girders tests have been conducted at the Engineering Experiment Station of the University of Illinois on a number of specimens consisting of 12-in. I-beams having webs planed down to a thin section and 24-in. built up girders having webs of thin plates. The test data were used in conjunction with a mathematical analysis to determine the importance of the diagonal strains and the methods of failure of girders. The results show (a) that, in general, the shearing stress is a maximum at the neutral axis, but that diagonal stress at the junction of web and flange must be considered, (b) that approximate methods of computing shearing stress in webs should, under certain conditions, be checked by more exact methods, (c) that stiffeners at supports and under concentrated leads are very necessary, and (d) a formula is developed for the buckling strength of webs.

The investigations were conducted by Professor H. F. Moore and Professor W. M. Wilson. The results are described in Bulletin No. 86, of the Engineering Experiment Station, copies of which may be obtained upon application to W. F. M. Goss, director, Urbana, Ill.

THE SUBJECT OF lightning arresters and the various types designed for particular classes of service are covered in a recent publication, Catalog I-A, entitled "Westinghouse Lightning Arresters." A discussion of lightning and its effects is given, followed by a discussion of the application of lightning arresters for the protection of various classes of apparatus, and types to be used with each.

Following this is given a general description, accompanied by illustrations of the different types of lightning arresters and accessories manufactured by the Westinghouse Electric & Mfg. Co. The catalog will be sent to anyone interested.

THE INGERSOLL-RAND CO., 11 Broadway, New York, has issued a catalog in Spanish under the title "Productos de la Ingersoll-Rand." This is attractively and substantially bound and contains 124 pages replete with illustrations, descriptive matter and tabulated data. The catalog covers completely the company's line of air and gas compressors, vacuum pumps, reciprocating

and centrifugal water pumps, rock drilling, metal and coal mining, prospecting and quarrying machinery and pneumatic tools for machine and boiler shop and foundry work. In short, this catalog is a complete reference book which should be of great service to Spanish-speaking users of pneumatic machinery.

SPRAGUE ELECTRIC WORKS of General Electric Co. recently issued Bulletin No. 48,705, describing and illustrating direct-current motors and controllers for flat-bed and small rotary printing presses.

A new electric fan bulletin, No. B3361, has just been received from the same company.

SMALL MOTORS No. 25 describes and illustrates Westinghouse alternating and direct current motors for washing machine service.

BADGER QUALITY self-equalizing copper expansion joints, which are one-piece and are made with 2, 3, 4 or 5 corrugations, are the subject of a new 16-page booklet from E. B. Badger & Sons Co., of Boston.

GENERAL ELECTRIC CO. has issued two booklets, "Novalux Street Lighting Units for Mazda Series Lamps," and "Street Lighting Brackets and Center Span Fixtures for Mazda Lamps," which should be of interest to those considering street lighting installations. Specifications and general data are given in each booklet.

Trade Notes

THE SANFORD Riley Stoker Co., Ltd., of Worcester, Mass., manufacturer of the Riley self-dumping under-feed stoker, has moved its main office from 72 Commercial St., into larger headquarters at 25 Foster St.

THE DIAMOND POWER SPECIALTY CO. of Detroit has just accepted a contract with the Ford Motor Co. for equipping the boilers in their new power plant with Diamond Soot Blowers. These are believed to be the largest boilers in the world. Their rated capacity is 2400 hp. and it is planned to operate them continuously at 4000 hp.

TO MEET a constantly increasing demand for Firma gage glasses, Tenox packing and other engineering specialties, the Advance Packing & Supply Co., of Chicago, have leased the store building adjoining their present location at 11 N. Franklin St. The new quarters will more than double their present floor space, and will be utilized chiefly as a salesroom and increase the facilities for the handling and storage of stock.

AMONG THE many new orders for steel mill equipment received by the Westinghouse Electric & Manufacturing Company of East Pittsburgh, Pa., are the following:

Equipment sold to the Baltimore Sheet and Tin Plate Co., consists of several large motors for main roll drive, 2 1200 hp. 36 to 60-cycle, 2200-volt, 244-r. p. m., wound rotor, induction motors, each motor to drive 6 hot mills and 1 750-hp. 26 to 60-cycle, 2200-volt, 367-r. p. m. wound rotor induction motor geared to 12 standard cold rolls.

Contract with the Chattanooga Steel Co. calls for one 34-in. blooming mill equipment consisting of an 8000 hp. motor and a flywheel motor generator set which acts as an equalizer.

Equipment sold to the Llewellyn Iron Works for their new plant at Los Angeles, Cal., consisted of 2 800-hp., 36 to 50-cycle, 2200-volt, 730 to 365-r.p.m., adjustable speed, wound rotor, induction motors, the first to drive a 22-in. billet mill, and the second to be geared to a 12-in. merchant mill. On this order there was also one 250-hp., 585-r.p.m., 36 to 50-cycle, 2200-volt, wound rotor, induction motor to be geared to a 14-in. roughing mill.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH.

SEMI-MONTHLY

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 So. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $60.00.

Half page, one year, each insertion, $35.00.

Quarter page, one year, each insertion, $20.00.

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Front cover $150.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

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Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED—As master mechanic or assistant; 21 years' experience. Had charge of erecting, repairing heavy duty engines, machinery and mixed blow turbines. Expert on lubricants. Address Practical Engineer, Box 435, Chicago, Ill. 8-1-1

POSITION WANTED—Chief engineer in a small plant or operator in a large; 12 years' practical experience with steam, electric, refrigerating, pumping and condensing equipment. Technical education. First-class license and references; married, age 31, employed. Practical Engineer, Box 434, Chicago, Ill. 7-1-3

POSITION WANTED—As Chief Engineer or Manager of produce cold storage plant. Am familiar with gas, oil and steam engine driven plants, also with D.C. light and power of 250 volts. Erecting, repairing and operating. Employed; married, and sober. Will go anywhere. Address Box 428, Practical Engineer, Chicago, Ill. 8-1-1

POSITION WANTED—License chief engineer wants change; 12 years' experience in manufacturing and central stations, steam, electric, refrigeration and producer gas, high speed and Corliss engines, condensers, etc. Age 32, American and married. Address Box 437, Practical Engineer, Chicago, Ill. 8-1-1

POSITION WANTED—By chief engineer, 35, married. Use no liquor; 15 years' experience, electrical and refrigeration. Wants position where ability and push will count. Can get results if given opportunity. Practical Engineer, Box 436, Chicago, Ill. 8-1-1

YOUNG MAN, age 26, would like a position as helper in engine room where good advancement is assured. Am I. C. S. student. Will send information. Box 429, Practical Engineer, Chicago.

POSITION WANTED—As Chief Engineer. Am qualified to take full charge of power plant, A.C. or D.C., also refrigeration. Age 30. Married. Employed. Chicago only. Address Practical Engineer, Box 421, Chicago, Ill. 8-1-1

POSITION WANTED—Young man wants position as helper, extra engineer or fireman. Two years' practical experience. I. C. S. student. Write Rasmus Stenner, 300 Fremont St., Portland, Ore. 7-1-3

WANTED—Position as engineer in pumping station or in some stationary plant. I have had 4 years' experience in engineering. What have you to offer? E. W. Adkins, Charleston, Ill. 7-15-2

POSITION WANTED—Young man wants position as helper and extra engineer in steam plant for a start. Other particulars answered by letters. Write to W. D. Bellesfield, Rock Valley, Iowa. 8-1-1

POSITION WANTED—By young man as oiler or fireman in a modern plant. I. C. S. graduate. Address Frank Knapp, 323 S. 5th St., St. Joseph, Mo. 7-1-3

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago. tf.

WANTED—Refrigerating Engineer for 20-ton Raw Water Ice and 200-gallon Ice Cream Plant. Electric driven throughout. Good steady position for right man. State salary. Address Practical Engineer, Box 444, Chicago, Ill. 8-1-1

Wanted

WANTED—Sales agent for Northwestern and Western Illinois and Eastern Iowa. To qualified sales producer, we offer an established and continuously advertised line of successful steam traps and temperature regulators. Liberal commission and complete co-operation from manufacturer. Address Practical Engineer, Box 443, Chicago, Ill. 7-15-1

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

WANTED—Agents to handle Chemicals for Boiler Rooms, Laundries and the Automobile Trade. Strictly commission basis. State age and experience. Address Practical Engineer, Box 440, Chicago, Ill. 6-1-6

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put it on test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

For Sale

FOR SALE CHEAP—A 150-hp. gas producer engine, direct connected to a 125-kw. dynamo, as also a 150-hp. gas producer. For further particulars, write Hilker-Wiechers Mfg. Co., Racine, Wis.

FOR SALE—14x36 E. P. Allis Corliss engine, 100 hp., 100 r.p.m., cylinder re-bored, thoroughly overhauled one year ago; was good as new. Dubuque Brewing & Malting Co., Dubuque, Ia. tf.

Patents and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Snd for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTS—Send sketch for free search and reports. Books and patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

QUESTIONS AND ANSWERS—Introductory set questions and answers on boilers sent on receipt of ten cents. Authentic and strictly educational. Richmond Engineering Bureau, Box 353, Haverhill, Mass. 8-1-1

Miscellaneous

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time, to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill.

Sparks From The Advertising Pages

"Confidence in advertising is now above par," said Mr. Merle Sidener in his recent address at the Philadelphia Convention of the Associated Advertising Clubs of the World.

"If it were possible for the truth-movement to close its books and submit a report in figures to this convention, it would show a net gain for the year that would be startling.

"Every class of business has shared in the dividends and the general business world has benefitted definitely because of the enlarged distribution of confidence.

* * * * *

"Organizations representing various industries have been doing their share of the confidence-creating work. *They have found their trade-papers more than willing to assist in crusading against trade-practices which are detrimental.* The furniture manufacturers and their trade publications are carrying on an agitation against the use of misleading trade-names such as American quartered oak, which is 'neither American in spirit nor quartered oak in fact.'

"The Government, through its Post Office Department, is of course the original opponent of dishonest advertising, and during the last year this department under the splendid management of Judge W. H. Lamar, solicitor for the Post Office Department, has won many signal victories. The National Vigilance Committee has enjoyed splendid co-operation from this branch of the Government. This work is done quietly, perforce, but the result has been the elimination of many frauds which preyed on the public and helped to destroy confidence in legitimate enterprises and their advertising.

"All in all, it has been a year of marked advancement in the creation of confidence in business. No longer does the mention of the words 'truth' and 'advertising' together cause a smile of amusement. No longer is there a widespread belief that advertising statements must always be taken with a grain of salt. The very fact that business organizations such as the Associated Advertising Clubs are behind the movement for better and more dependable advertising, is having a psychological effect and the public is gradually assuming it to be a fact that advertising is worthy of confidence.

"It is only necessary to look at the last five years in perspective to see clearly the changed public attitude toward advertising. The improved conditions encourage us to go forward with renewed determination. We do not yet enjoy '100 per cent distribution' of confidence. *That must be our aim. We must conserve that which we have and fight for the ideal 100 per cent."

(**Readers of Practical Engineer can absolutely rely on every advertisement printed in its advertising section.*)